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- Spécification du produit
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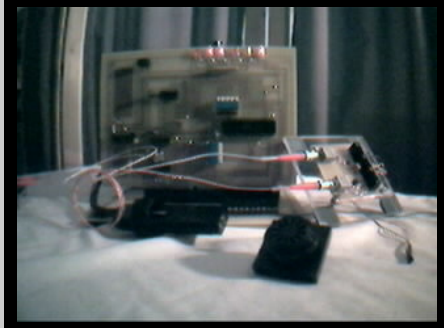
Introduction



DESCRIPTION SOMMAIRE DU PRODUIT :
Le " LMKG série 2001 " est un système d'alarme programmable à dispositifs de sécurité multiples, conçu pour tout établissement nécessitant une surveillance constante. Il a été conçu en premier lieu comme matériel pédagogique pouvant servir dans les cours de Projets et de Dépannages. Le système est modulaire et facile à dépanner.

Le système " LMKG " comprend quatre modes de détection :

- Caméra de surveillance fixe servant de témoin pour l'endroit à surveillé.
- Détecteur de mouvement par réflexions.
- Capteur de chaleur programmable.
- Capteur magnétique, pour détecter un déplacement.

Tous les capteurs sont reliés au système d'alarme. Du système d'alarme les données sont transmises par fibre optique full duplex jusqu'à l'interface (convertisseur port série rs-232) au PC. Le PC pourra ainsi lire toutes les informations utiles telles que la température, introduction d'un intrus et déplacement d'un objet.

Ce système est idéal pour contrôler la sécurité et réduire le nombre d'agent de sécurité. Le " LMKG série 2001" est indispensable pour toutes applications commerciale, gouvernementale et industrielles.

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Introduction

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Spécifications

SPÉCIFICATIONS DU PRODUIT

Le système est subdiviser en trois parties distinctes :

- Un système de traitement de l'information.
- Un système de transmission/réception.
- Un système de gestion.

Chaque parties seront détaillées dans les lignes suivantes :

Spécification du capteur électromagnétique

capteur électromagnétique	
sortie	deux états possibles
alimentation	+5 volts DC

Spécification du capteur de température

Capteur de température	
sortie	deux états possibles
alimentation	+5 volts DC

Spécification du détecteur de mouvement

Capteur de mouvement	
sortie	numérique
alimentation	+30 volts DC

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Spécifications

Spécifications de la carte I/O

Carte I/O	
entrée	deux états: capteur de température, capteur de mouvent, capteur infra-rouge, module fibre optique vers micro-contrôleur
alimentation	+15 v, -15 v, +5 v
Amplificateur de température	gain de 10 avec un offset de 1volt
Amplificateur de détecteur de mouvement	gain de 18
2 buffers	utilisé les portes ET du 7400
sortie	numérique: avertisseur sonore, led vert, led rouge, lien f.o vers le pc

Spécifications de la carte RS-232

RS-232	
entrée/sortie	deux états
alimentation d'entrée	+5 volts DC
alimentation de sortie	+12 v, -12 v, port série du pc

Spécifications du TX/RX fibre optique

TX/RX	
entrée/sortie	deux états
alimentation	+5 volts
taux de transfert max	9600
communication	full duplex
fibre optique	multimode, 62.5/125 micro-mètre
type de connecteur	ST

Pour des spécification sur le UART et le micro-contrôleur, voir la page de référence.

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Installation

MATÉRIEL REQUIS:

- 1 kit LMKG série 2001
- Ordinateur
- 1 tournevis étoile moyen

LISTE DES PIÈCES POUR UN KIT DE LMKG SÉRIE 2001

- 1 Boîtier
- 1 Bloc d'alimentation (+/-5Vdc +/- 12 V dc +/- 30 V dc)
- 1 Carte bus
- 1 Carte Contrôleur MC
- 1 Carte Communication série UART
- 1 Carte I/Oü 1 Carte interface rs-232
- 1 Carte win TV
- 1 Disquette
- 1 Avertisseur sonore
- 1 Capteur électromagnétique
- 1 Capteur de chaleur
- 1 Détecteur de mouvement
- 1 Mini-caméraü 1 Fil RCA
- 2 Transmetteurs à fibre optique
- 2 Récepteurs à fibre optique
- 2 Fibres optiques ü 1 Plaque réfléchissante
- 1 Sac de vis

PROCÉDURE D'INSTALLATION

1. Déballer les pièces et vérifiez la liste.
2. Fixer le bloc d'alimentation et alimenter la carte bus à +5V dc et +/-15 V dc, le détecteur de mouvement à +/-30 V dc, les transmetteurs et récepteurs à 5V dc et le RS-232 à+5V dc.
3. Alimenter la mini-caméra 120V ac.
4. Installer la " Carte Contrôleur MC " dans la fente MC de la carte Bus.
5. Installer la " Carte Communication série UART " dans la fente COM de la carte Bus.
6. Installer la " Carte I/O " dans une des fente I/O de la carte Bus
7. Installer la " Carte interface RS-232 " à l'arrière de l'ordinateur sur un port série libre.

Mini-caméra

1. Avant d'installer la carte Win TV mettre le PC hors tension.
2. Toucher le châssis du PC avec la main pour décharger de toute électricité statique, avant de sortir la carte de son emballage.
3. Insérer la carte Win TV dans le connecteur PCI disponible(connecteur bu- master PCI).Il est important que Windows 95/98 soit installé.
4. Pour installer la caméra, il suffit de raccorder la prise RCA(vidéo)de la caméra à la prise RCA de la carte Win TV dans le PC.
5. Alimenter la caméra à l'aide du bloc d'alimentation fourni.
6. Ouvrir le programme hauppauge,Win TV 32.

Avertisseur sonore

1.L'alimentation de l'avertisseur sonore est sur la carte I/O (5 Vdc)
2.Installer l'avertisseur prêt de l'objet à protéger.

Capteur de chaleur

1.Alimenter à 5Vdc+mise à la terre..
2.Installer la capteur de chaleur dans le centre de la pièce pour avoir une meilleur température d'ensemble.

Capteur électromagnétique

1.Alimenter 5 Vdc +mise à la terre.
2.Installer le capteur sous l'objet.

Détecteur de mouvement

1.Alimenter à 30Vdc +mise à la terre.
2.Installer le détecteur de mouvement devant l'objet a protéger et installer la plaque réfléchissante devant l'objectif.

Module transmission et de réception à fibre optique

1.Toujours installer les deux connecteurs au module à fibre optique avant d'alimenter les modules, pour la transmission et la réception.
2.Ne jamais regarder dedans la fibre si elle est allimentée.
3.Alimenter le premier module à 5 Vdc + la mise à la terre.
4.Installer le module 1 prêt du boiter du système d'alarme.
5.Alimenter le module2 à 5 Vdc +la mise à la terre.
6.Installer l e module 2 prêt du PC et installer entré et la sortie du module au RS-232.

Programme principale

1.Insérer la disquette du programme principale dans le lecteur A.
2.Aller dans le poste de travail, double click sur disquette A et double click sur install Ce programme crée un icône sur le bureau et copie les fichiers dans l'ordinateur.
3..Exécuter le programme.
4.Choisisser votre code d'accès et un nom d'utilisateur. 7. Relier avec le câble coaxiale de 20 cm la carte Communication RF 916 MHz au connecteur du boîtier. 8. Fermer le couvercle & connectez l'antenne sur le connecteur du boîtier 9. Brancher les senseurs, sonde, actionneur etc. sur la carte I/O

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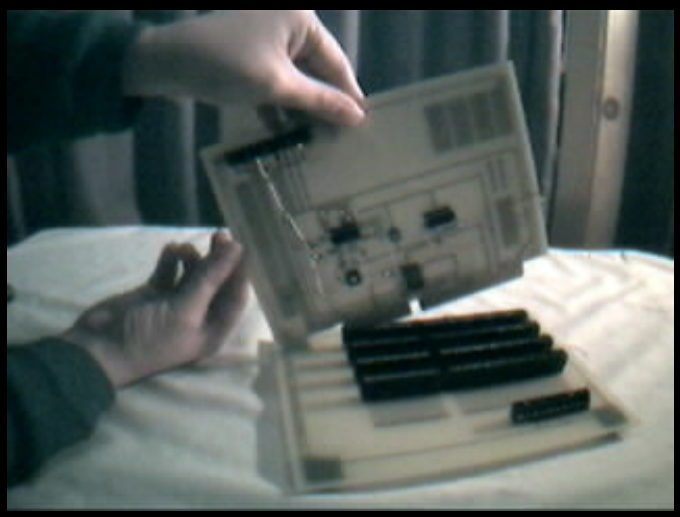
Installation(suite)

CARTE BUS ISA

À partir de cette carte vous pouvez insérez les cartes à connection ISA Chaque emplacement est bien identifier.

Carte I/O

Vous insérez la carte I/O



Carte micro-contrôleur

Vous insérez la carte du micro-contrôleur

Carte UART

Vous insérez la carte du UART

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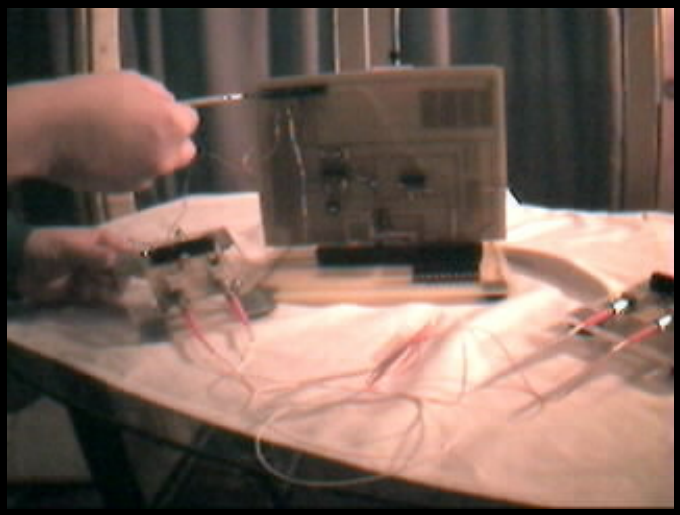
Installation

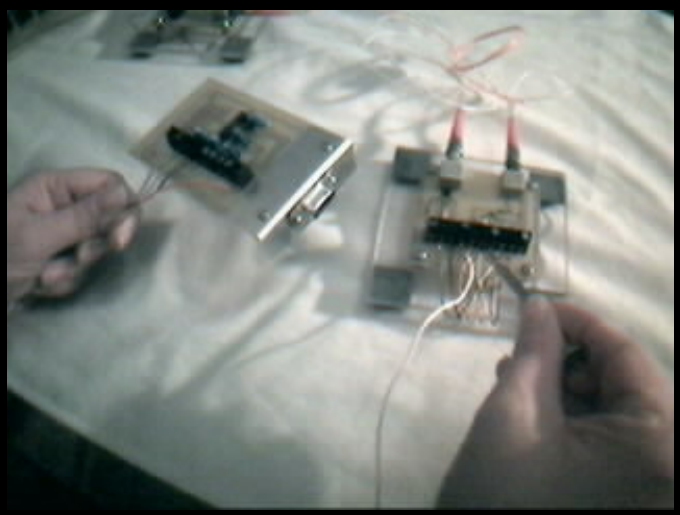
Fibre optique

Pour alimenter le module de la fibre optique TX/RX, on prend l'alimentation sur le bornier de la carte I/O(5V, mise à la terre)



MAX RS-232

On installe le MAX 232 à la sortie du module de la fibre optique (Vin et Vout) et le RS 232 à l'entrée du connecteur DB-9(série) du PC" et les quatre capteurs sont installés sur les borniers de la carte I/O.



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Fonctionnement global

Fonctionnement global:

Fonctionnement global

Avertisseur sonore : Lorsqu'une alarme est activée, l'avertisseur sonore se met en fonction.

Capteur magnétique : Le capteur magnétique gère les allée et venue dans la pièce à protéger.

Capteur infra-rouge : Il détecte tout mouvements dans la pièce autour de l'endroit à protéger

Capteur de température : Lis la température ambiante de la pièce afin de respecter les normes pré-établies.

Carte I/O : Elle adapte les signaux provenant des capteurs afin qu'ils soient correctement transmis au micro-contrôleur. Elle sert aussi d'interface entre le UART et le module TX, RX fibre optique .

Caméra : La caméra de surveillance sert de gardien virtuel à l'endroit protégé. Elle est reliée directement à l'interface de l'usagé (PC) par câble RCA et n'a aucune relation avec les autres modules du système.

Micro-contrôleur : Le programme insérer dans le micro-contrôleur gère les capteurs reliés à la carte I/O et transmet numériquement au UART l'information provenant de cette dernières.

UART : Sa principale fonction est de convertir les données parallèle provenant du micro-contrôleur en données sérielles à des fins de transport et vice-versa.. Il est relié à la carte I/O pour permettre la transmission des données au module TX-RX fibre optique.

Modules de transmission et de réception fibre optique : Ces deux modules adaptent le signal électriques à la sortie du UART en signal lumineux afin qu'il soit transmis sur fibre optique et reconverti en signal électrique avant d'entrée dans le MAX-232. N.B :Le premier module est relié à la carte I/O car c'est elle qui sert de lien entre le UART et le module fibre optique.

MAX-232 : Sert d'interface entre le UART et le poste de l'usagé. Il converti les données série +5 volts qu'il reçoit en données sérielles bipolaires NRZ (+12 et -12 volts) et vice-versa. Il est relié au UART par les deux modules de TX-RX fibre optique.

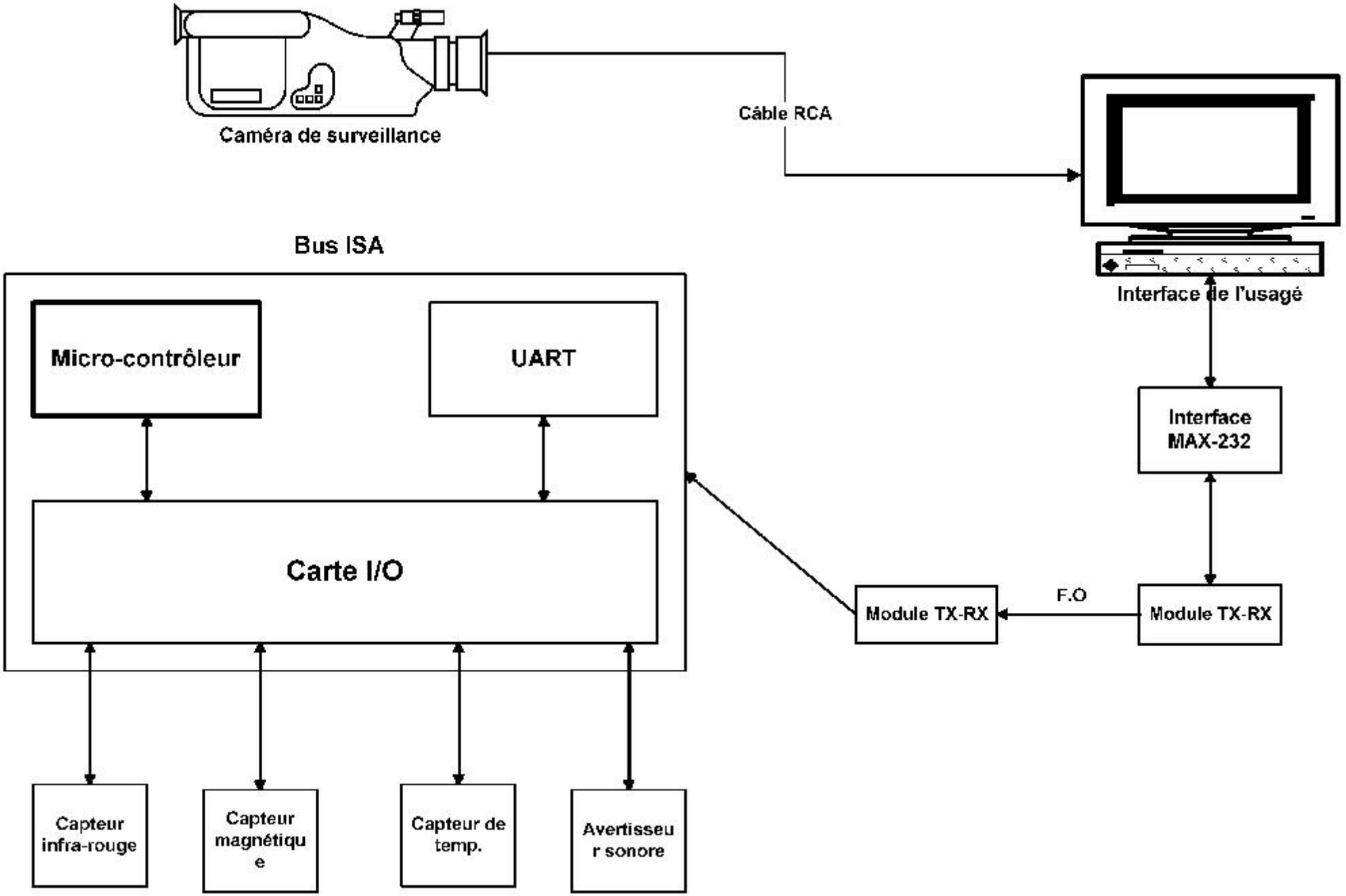
Poste de l'usagé : Agit comme poste de contrôle pour tous les modules contrôlés par le micro-contrôleur. Il permet l'activation et la désactivation du système d'alarme. Un code d'utilisateur est nécessaire afin d'y accéder.

Carte bus : Elle est utilisée comme support et inter relie la carte M.C, huart et la carte I/O .

Plan de fonctionnement

À la page suivant vous pourrez visionner le fonctionnement de la programmation utilisée pour le projet.

NEXT


Caméra de surveillance
Câble RCA
Interface de l'usagé
Bus ISA
Micro-contrôleur
UART
Carte I/O
Interface MAX-232
Module TX-RX
F.O
Module TX-RX
Capteur infra-rouge
Capteur magnétiqu e
Capteur de temp.
Avertisseu r sonore

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Fonctionnement (suite)

Fonctionnement des programmes Micro- contrôleur et visual basic.

Le LMKG alarme série 2001 possède un interface facile d'utilisation crée à l'aide de Visual Basic. Dans ce chapitre une brève explication du fonctionnement des programmes vous aideront à mieux comprendre de quel façon fonctionne le système.

Micro- contrôleur

Le micro contrôleur 68705 R3 à été programmer de tel façon, que lorsque le système se met en marche, il transmet des données envers l'interface PC afin de donnée l'état des capteurs ainsi que l'état de la température. Si un capteurs est activé ou si la température augmente ou s'abaisse à des point critiques, le micro déclenche automatiquement un avertisseur sonore en plus d'un voyant lumineux rouge pour signifier qu'il y a alarme. Ensuite le micro envoie l'état de ses capteurs et de la température vers le Pc.

voir l'organigramme de transmission du micro-contrôleur

voir l'organigramme de réception du micro-contrôleur

voir la programmation

Visual Basic

L'interface sur le Pc à été crée à l'aide de VB. Le fonctionnement de la programmation VB est comme suit. Premièrement , lorsque l'utilisateur met en fonction l'interface à l'aide de son nom et de son mot de passe, le Vb active le port série afin de recevoir les données envoyer par le micro. Ensuite il gère la longueur de la trame envoyer par le micro afin de bien mettre les bonne données aux bons endroits. Par exemple lorsque le Pc a reçu le caractère " a " envoyer par le micro, il sait que c'est le début de la trame et commence à entrer ses données dans le buffer et lorsque sa trame est complète il affiche les résultats à l'écran. Lorsque l'usager se " log " une caméra est activer afin de pouvoir avoir une vue d'ensemble de l'endroit à surveiller. Sil y a alarme, l'interface indique clairement à l'usager à l'aide de dessin représentatif qui se met à flasher où se situe l'alarme. De plus, si l'usager ne se retrouve pas devant son poste au moment de l'alarme, le VB envoie un message directement sur le paget de l'usager.

voir l'organigramme générale

voir l'organigramme de réception

NEXT

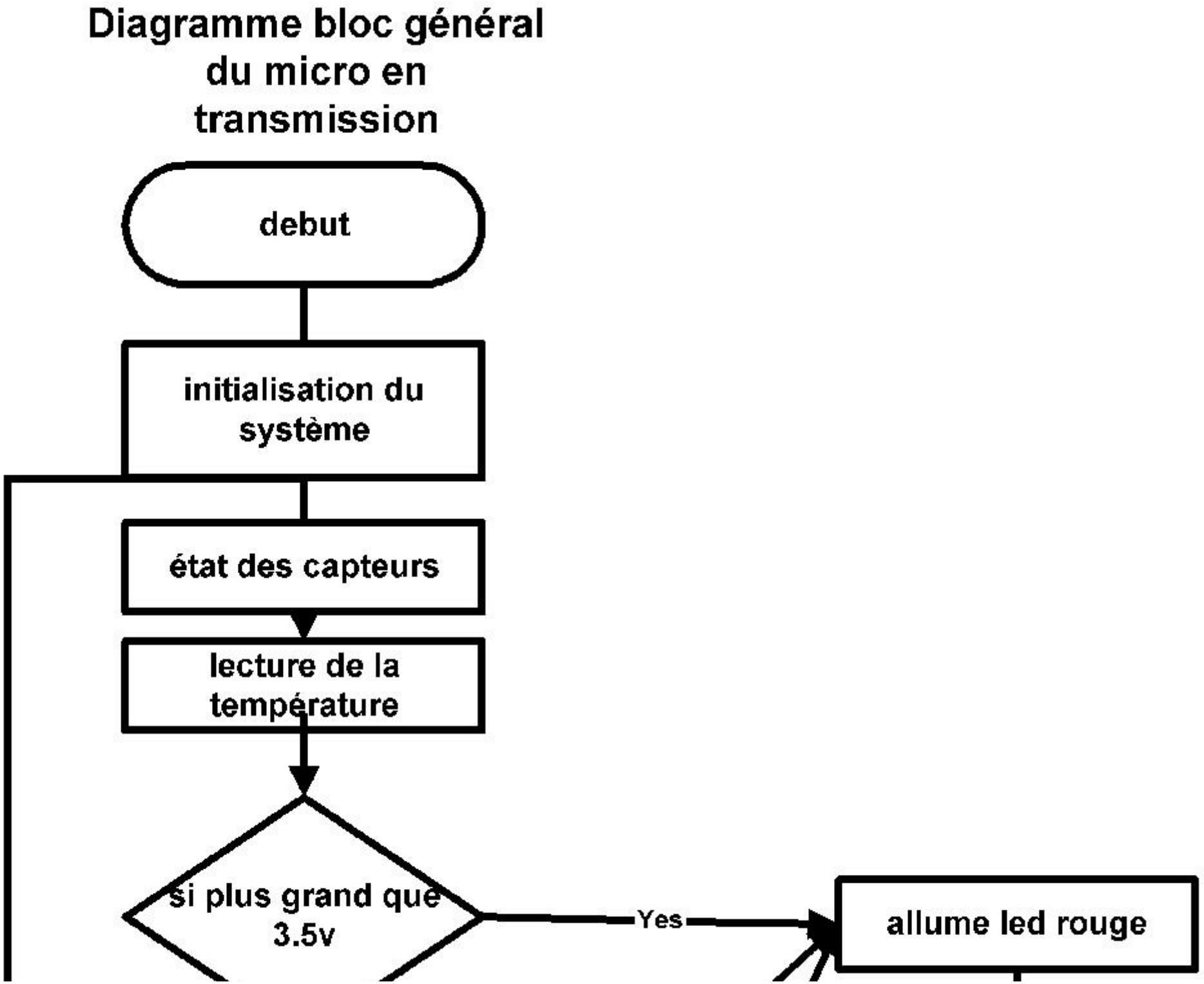
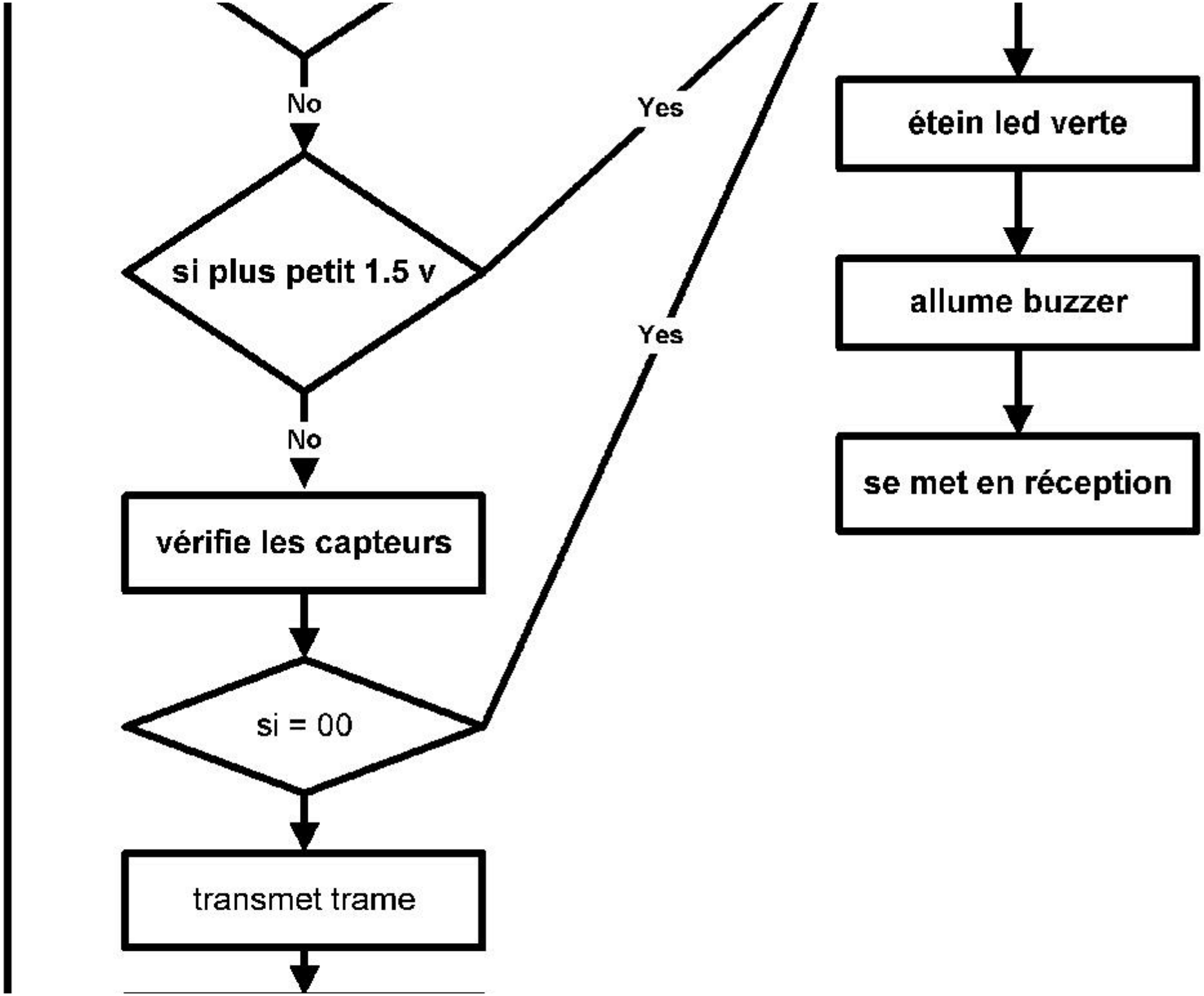
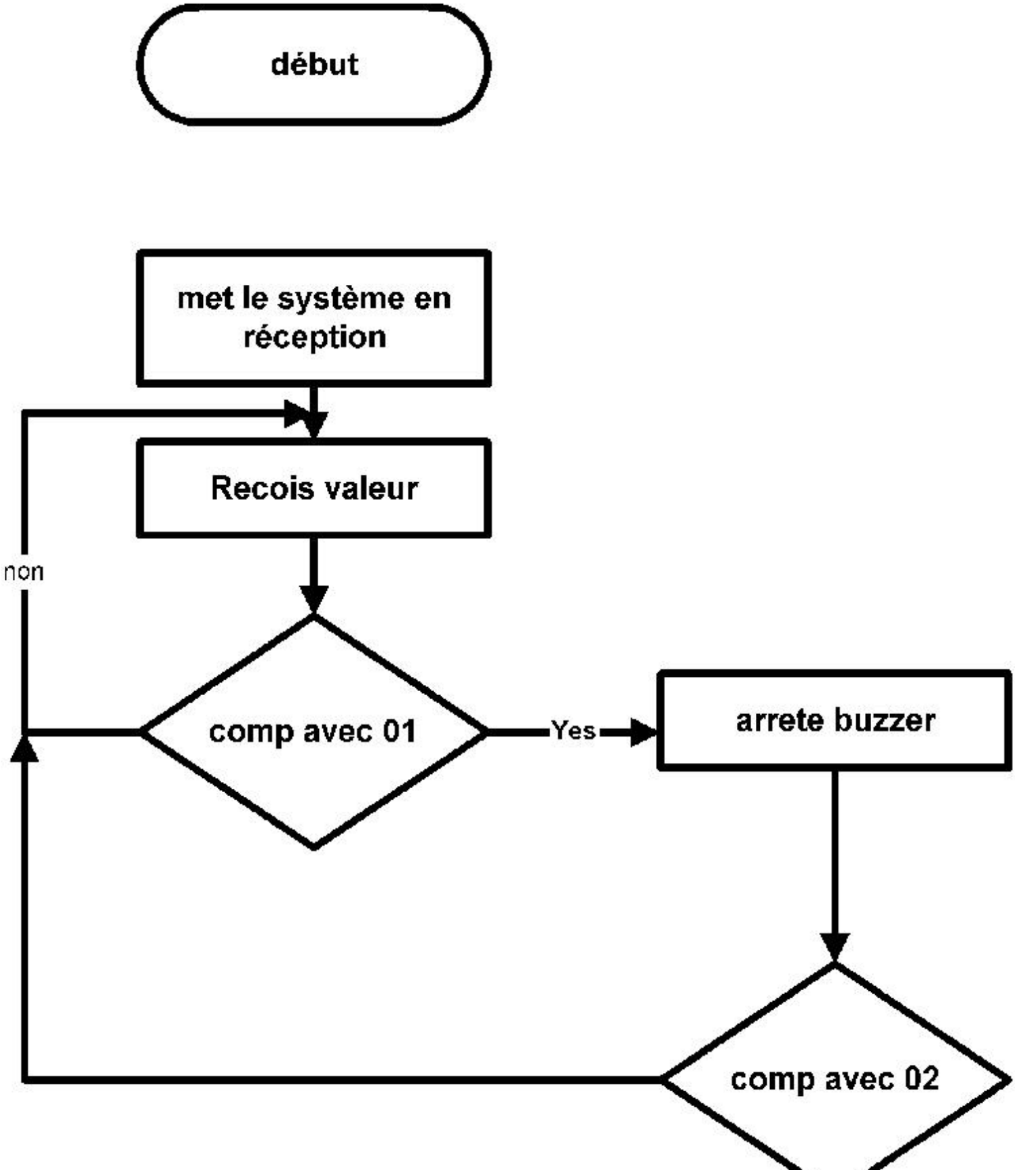


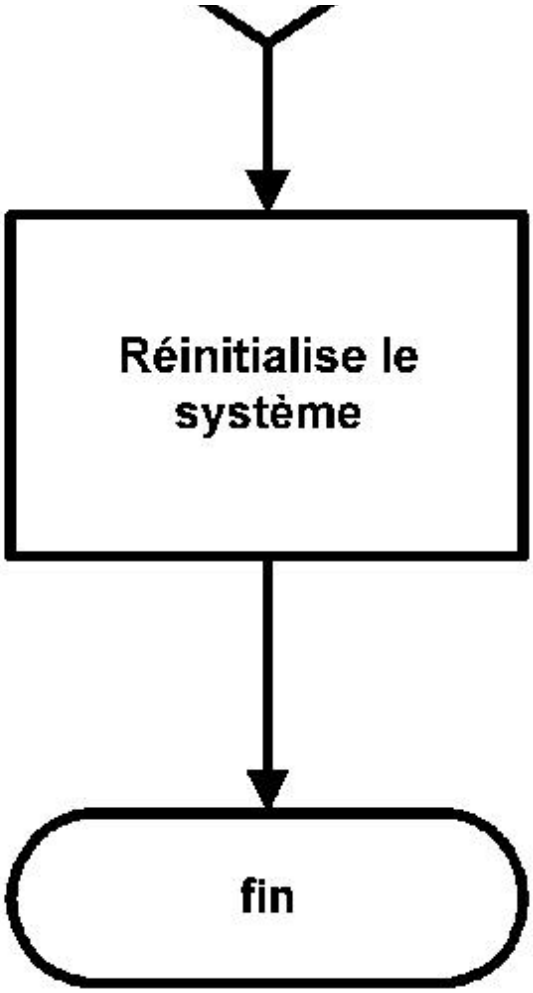
Diagramme bloc général du micro en transmission
debut
initialisation du système
état des capteurs
lecture de la température
si plus grand que 3.5v
Yes
allume led rouge


No
Yes
si plus petit 1.5 v
Yes
No
vérifie les capteurs
si = 00
transmet trame
étein led verte
allume buzzer
se met en réception

attend

Diagramme bloc du micro en réception




Réinitialise le système
fin

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Programme du micro-contrôleur

```
**************************************************
* Projet : SYSTEME D'ALARME *
* Titre : Programmme Test pour TEMPERATURE *
* *
* Fichier : UARTEST2.ASM *
* Auteur : MARTIN GAGNON *
* Vers Orig : V1.0 *
* Date : 01/12/2000 *
* Vers Cour : V1.1 *
* Date : 01/12/2000 *
* Note Vers : *
* *
* Ordinateur : PC *
* Compilateur : IASM05 *
* Microcontrl : MC68705 R3 *
* Fonct Prg : *
**************************************************
* Definition des Variables *
**************************************************
Debut EQU $80 ; Adr debut du code PRG
PortA EQU $00 ; Adr Port Interrupteurs
PortB EQU $01 ; Adr port d'Affichage
PortC EQU $02 ; Adr Port 3 LED et +
DDRA EQU $04 ; Adr Data Direct Port A
DDRB EQU $05 ; Adr Data Direct Port B
DDRC EQU $06 ; Adr Data Direct Port C
TDR EQU $08 ; Adr Regist Data Timer
TCR EQU $09 ; Adr Regist Contrl Timer
MR EQU $0A ; Adr Regist Miscellaneous
ACR EQU $0E ; Adr Regist Contrl A/N
ARR EQU $0F ; Adr Regist Result A/N
VALEUR EQU $10 ; memorise le valeur A/N
Temp1 EQU $12
Temp2 EQU $13
Temp3 EQU $14
ATemp EQU $15 ; Adr Temporaire accumulateur
XTemp EQU $16 ; Adr Temporaire reg index
XTemp1 EQU $17 CAPTEUR EQU $18 ; MEMORISE ETAT DES CAPTEURS
ALARME EQU $19 ; ETAT DE L ALARME
CAPT1 EQU 0 ; PD0
CAPT2 EQU 1 ; PA5
CAPT3 EQU 2 ; PA6
LED1 EQU 4 ; PC0
LED2 EQU 5 ; PC1
BUZZER EQU 6 ; PC2
TBRL EQU 3 ; Bascule INV pour activer
```

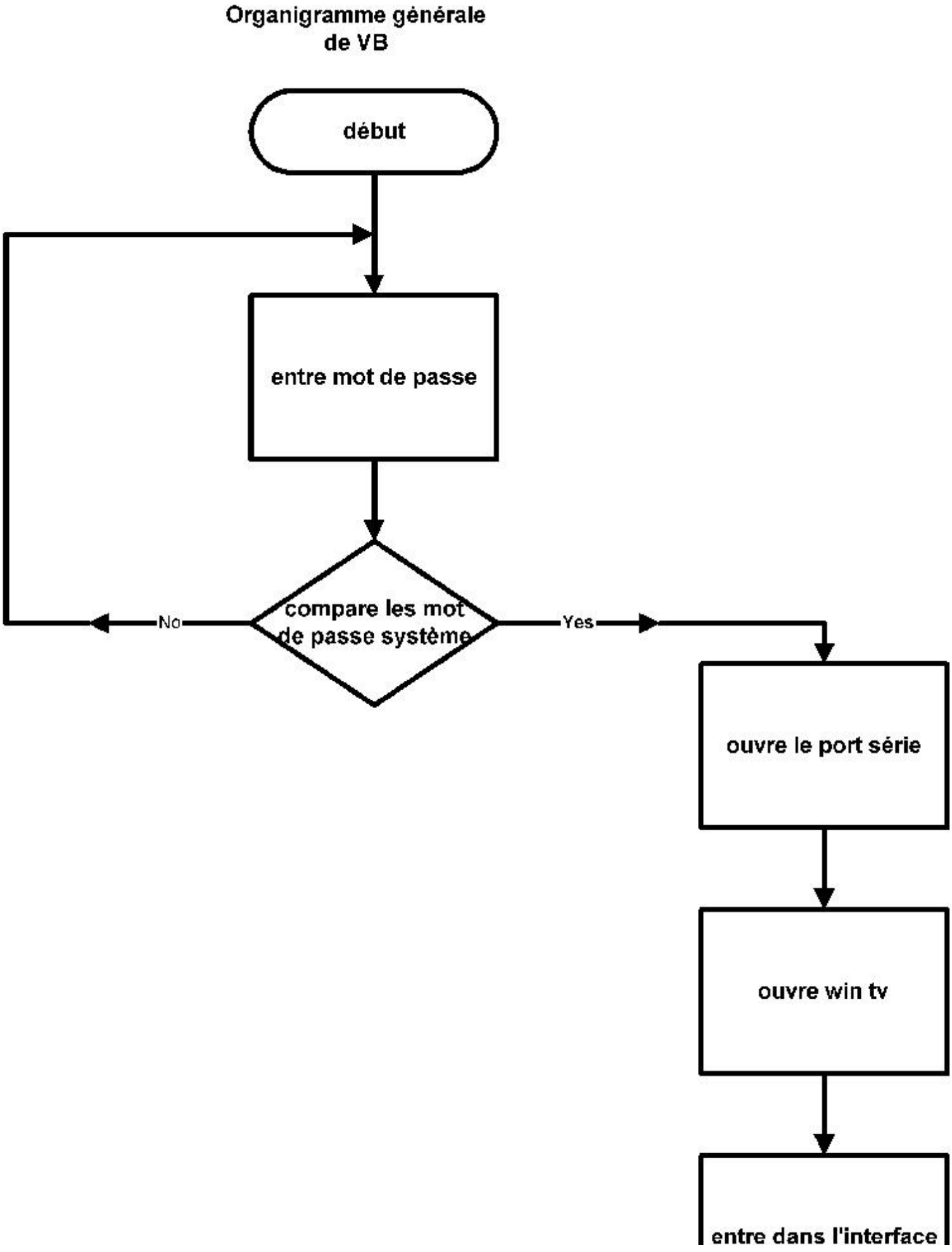
```
; la Tx du UART ( PA0 )
; CTRL sur PB1
;CRL EQU ; Bascule pour charger les
; param de Tx et Rx du UART
; CTRL sur PA1
DDR EQU 1 ;
TRE EQU 2 ;

RRD EQU 0


Vecteurs EQU $FF8 ; Adr depart des Vecteurs


*****************************************************
* Debut du Programme *
*****************************************************
ORG Debut
*****************************************************
* UART RBR1-8 HIGH IMPEDANCE *
*****************************************************
DEPART_RESET BSET RRD,PORTA ; MET LE UART EN TX ET MET
; EN HAUTE IMPEDANCE LE
; RBR1-8

*****************************************************
* Initialisation des variables *
*****************************************************

CLR XTemp
CLR ATEMP
CLR TEMP1
CLR VALEUR
CLR CAPTEUR
CLR ALARME
*****************************************************
* Definition des Ports en Entree/Sortie *
*****************************************************
* LE PORT A: *
*****************************************************
LDA #%10011011 ;Les 8 bits du port A
STA DDRA ;sont defini en entrees/SORTIE
*****************************************************
* LE PORT B: *
*****************************************************
LDA #$FF ;Les 8 bits port B
STA DDRB ; PORT DATA UART
*****************************************************
* LE PORT C: *
*****************************************************
LDA #%00001111 ;Les 8 bits du port C
STA DDRC ;

JSR SRINITUART ; Initialise le UART

*****************************************************
* Programme Principal *
*****************************************************
```

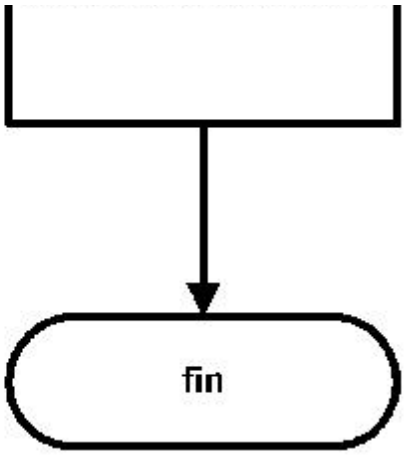
```
BSET RRD,PORTA ; MET LE UART EN TX ET MET
; EN HAUTE IMPEDANCE LE
; RBR1-8

DEPART BCLR 0,PORTC
BSET 1,PORTC
BCLR 2,PORTC
LDA PORTA
AND #%01100000
LSRA
LSRA
LSRA
LSRA
LSRA
STA CAPTEUR
JSR SRLIREVALEUR; lit le Canal 0
JSR SRAFFICHE ; AFFICHE VALEUR
LDA Valeur ;
CMP #!178 ; ( 3.5V )
BHI MSG1 ;
CMP #!76 ; ( 1.5V )
BLO MSG1
LDA CAPTEUR
CMP #$00
BEQ ATTEND
MSG1 JSR ALLED ; (ALLUME LED)
BSET 2,PORTC
JSR SRMSG1
JSR SRMSG1

JSR SRRECEPTION ;INCLURE SOUS ROUTINE DE RECEPTION DE CARACTERE
BRA DEPART
ATTEND JSR SRMSG1

JSR SRDELAI
BRA DEPART ; RECOMMENCE



*****************************************************
* SECTION SOUS-ROUTINE *
*****************************************************

*****************************************************
* Sous Routine: Initialise le UART *
*****************************************************
SRINITUART BSET TBRL,PortA ; Init TBRL

BSET DDR,PortA ; DRR -|_|-
NOP
BCLR DDR,PortA ; Charge parametres
NOP ; de TX et de Rx
BSET DDR,PortA ; (e.i. 8 N 1 )

RTS

*****************************************************
* Sous Routine: Lecture d'un Canal 0 *
*****************************************************
```

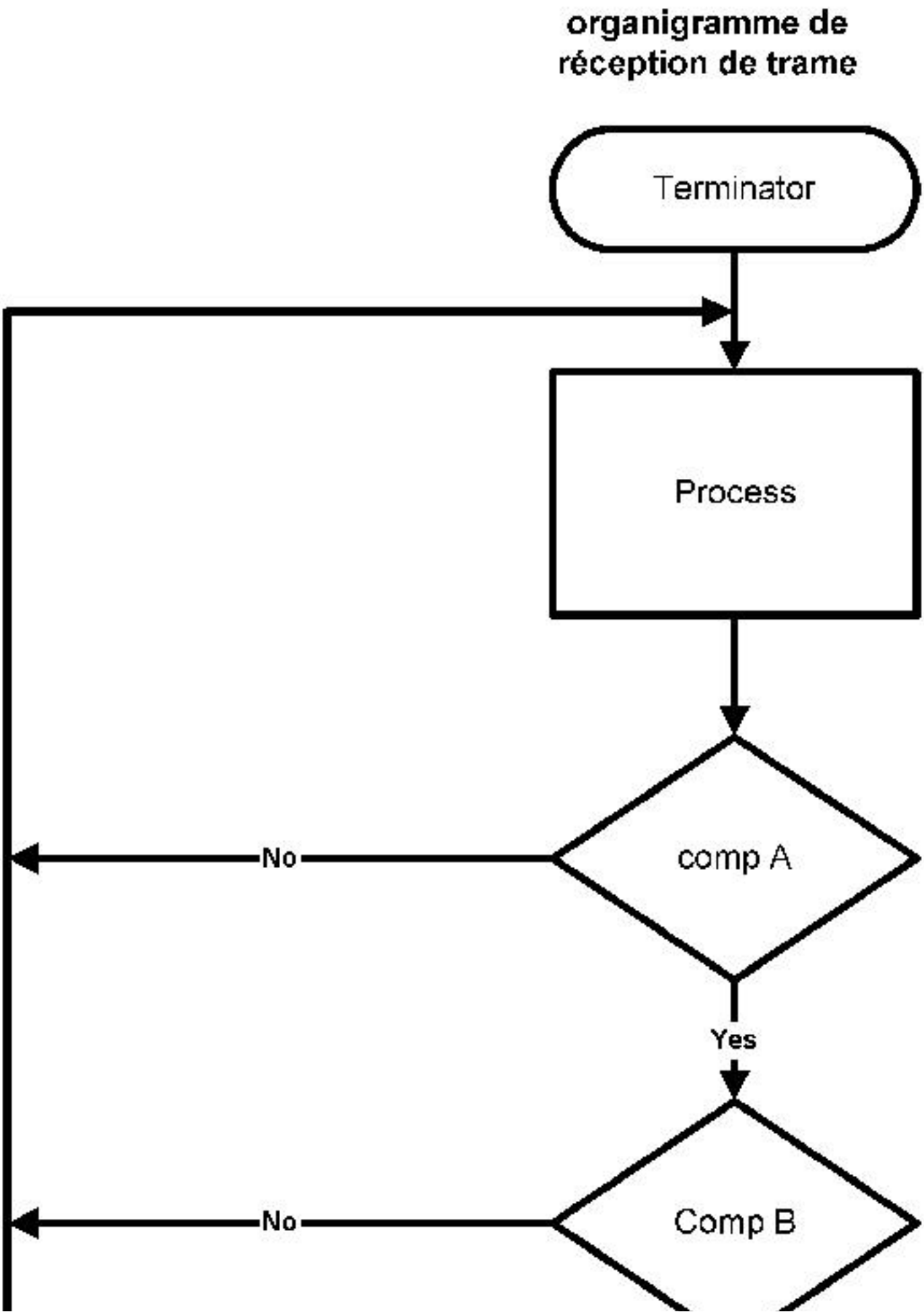
```
SRLIREVALEUR LDA #$00 ; choisi canal 0
; et active Conv
STA ACR
LOOPAN0 BRCLR 7,ACR,LOOPAN0
LDA ARR
STA VALEUR ; sauve valeur
RTS




*****************************************************
* Sous Routine: TRANSMETTRE TRAME *
* *
*****************************************************
SRMSG1 LDA #'A' ; BIT DE VERIFICATION
JSR SRUARTXCAR ; affiche 1 caractere
JSR SRDELAI
LDA #'B' ; BIT DE VERIFICATION
JSR SRUARTXCAR ; affiche 1 caractere
JSR SRDELAI
LDA #'C' ; BIT DE VERIFICATION
JSR SRUARTXCAR ; affiche 1 caractere
JSR SRDELAI
LDA #'D' ; BIT DE VERIFICATION
JSR SRUARTXCAR ; affiche 1 caractere
JSR SRDELAI
LDA VALEUR ; ENVOIE TEMPÉRATURE
JSR SRUARTXCAR ; affiche 1 caractere
JSR SRDELAI
LDA CAPTEUR ; ÉTAT DES CAPTEURS
ADD #$30
JSR SRUARTXCAR ; affiche 1 caractere
JSR SRDELAI
LDA ALARME ; ETAT DES ALARMES
JSR SRUARTXCAR ; affiche 1 caractere
JSR SRDELAI
LDA #'E' ; BIT DE FIN
JSR SRUARTXCAR ; affiche 1 caractere
JSR SRDELAI
RTS ; retour prog princ
*****************************************************
* Sous Routine: TX un CARACTERE AVEC UART *
*****************************************************
SRUARTXCAR STA PortB ; Place la donnee
; sur Reg TX UART
; TBR0-TBR7
NOP
NOP


BCLR TBRL,PortA ; Active la transmission
NOP
NOP ; Dmin 150 ns
BSET TBRL,PortA ;
RTS
```

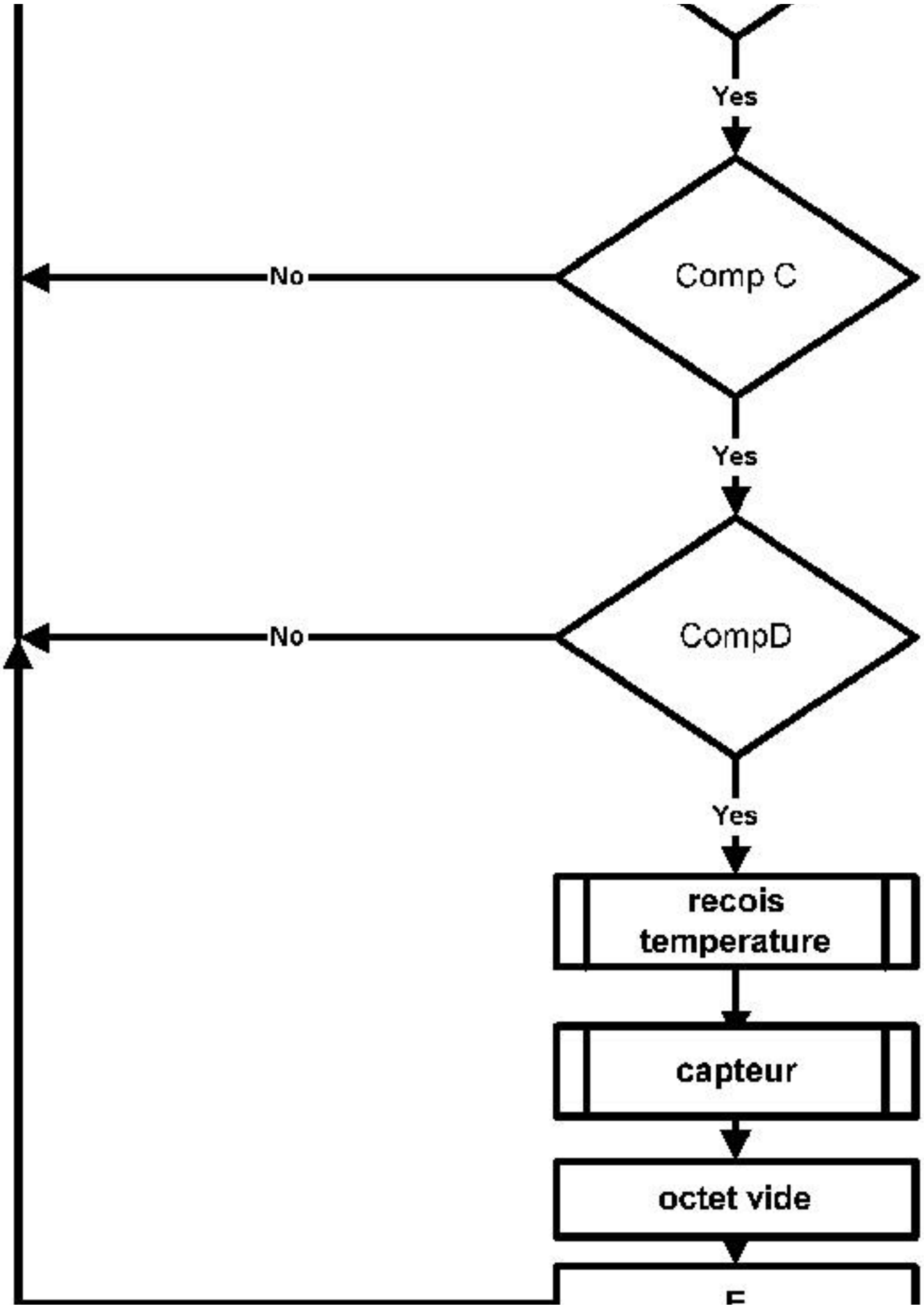
```
*****************************************************
* Sous Routine: DELAI ENTRE LES LECTURES *
*****************************************************
SRDELAI LDA #$FF ; Nombre de fois que la boucle
; interne sera repetee(1 a 255)
CompInt LDX #$FF ; Valeur a compter de la boucle interne
Compteur DECX ; Decremente la Valeur a Compter interne
BNE Compteur; Branche a Compteur si CompInt n'est pas zero
DECA ; Enleve 1 a la valeur cible
BNE CompInt ; Recommence la boucle interne tant que
; la cible n'est pas zero
RTS


*****************************************************
* Sous Routine : d'affiche *
*****************************************************
SRAFFICHE LDA VALEUR ; LIRE VALEUR
STA PORTB ; AFFICHE PORT B
RTS
*****************************************************
* SOUS-ROUTINE LED *
*****************************************************

ALLED BSET 0,PORTc ;
bclr 1,portc ;
A CHANGER RTS




*****************************************************



*****************************************************
* SOUS-ROUTINE DE RÉCEPTION DE CARACTERE *
*****************************************************
SRRECEPTION LDA #$00
STA DDRB
BCLR RRD,PORTA ; REMET LE UART EN RECEPTION

STOP LDA PORTB
STA ALARME
CMP #%00000001
BNE STOP
BCLR 2,PORTC
STOP1 LDA PORTB
STA ALARME
CMP #%00000010
BNE STOP1
BSET RRD,PORTA ; MET LE UART EN TX ET MET
; EN HAUTE IMPEDANCE LE
; RBR1-8

LDA #$FF
STA DDRB
```

```
BCLR 0,PORTC
BSET 1,PORTC
CLR XTemp
CLR ATEMP
CLR TEMP1
CLR VALEUR
CLR CAPTEUR
CLR ALARME
RTS




**********************************************************
* Definition des Vecteurs d'Interruption *
**********************************************************
ORG Vecteurs
IntTimer FDB DEPART
IntExterne FDB DEPART
IntLogiciel FDB DEPART
Reset FDB DEPART_RESET
```


Organigramme générale
de VB
début
entre mot de passe
compare les mot
de passe système
No
Yes
ouvre le port série
ouvre win tv
entre dans l'interface


fin


organigramme de
réception de trame
Terminator
Process
comp A
No
Yes
Comp B
No


Yes
Comp C
No
Yes
CompD
No
Yes
recois
temperature
capteur
octet vide

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Procédures de tests

procédures de tests

Procédure de test : Test du capteur magnétique

1- Alimenter le capteur avec une tension de 5 volts.

2- Installer les sondes d'oscilloscopes.

3- Calibrer les sondes d'oscilloscopes.

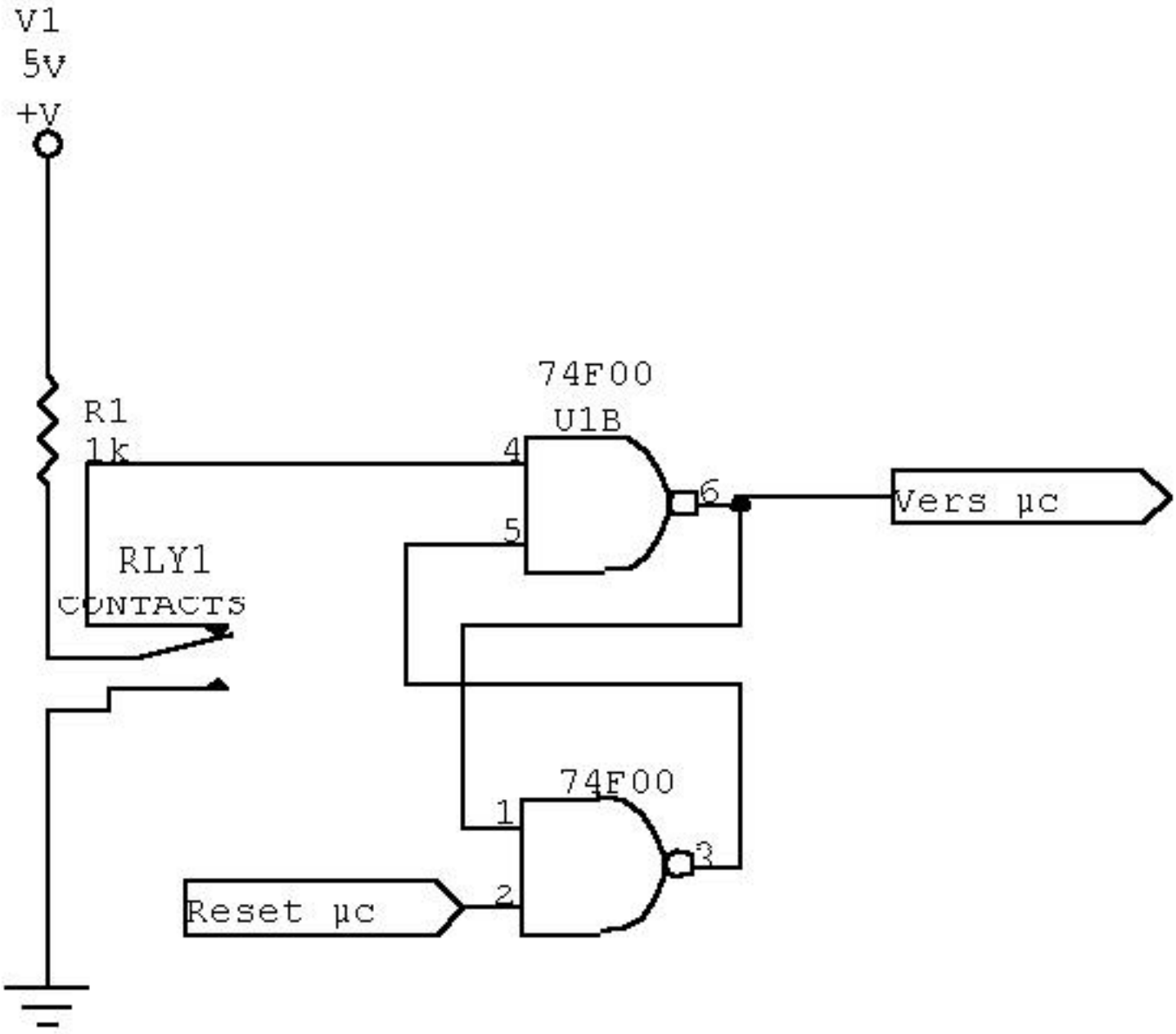
4- Mettre sous-tension.

Résultats du test # 6 : Test du capteur magnétique

1- Lorsque l'aimant est rapproché du contact, à l'écran de l'oscilloscope, une tension continue de 5 volts est obtenue. Ce qui indique que le relais est en position ouvert et qu'il n'y a pas de continuité électrique à l'intérieur de celui-ci.

2- Quand l'aimant est éloigné du contact, la tension aux bornes de celui-ci devient nulle. À ce moment le courant est maximum et est limité par une résistance de 1kW située entre la source et le contact.

capteur magnétique


V1
5v
+V
R1
1k
RLY1
CONTACTS
74F00
U1B
4
5
6
Vers µc
74F00
1
2
3
Reset µc

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Procédure de tests (suite)

suite...procédures de test

Procédure de test : Test de l'avertisseur sonore

1- Alimenter le capteur à 5 volts.

Résultats du test : Test de l'avertisseur sonore

Des qu'il est alimenté, l'avertisseur sonore émet un signal.

Avec le multimètre nous avons vérifié combien de courant est consommé (2 milliampères).

Avec la programmation, l'avertisseur sonore va fonctionner par intermittence dès qu'un capteur détecte une situation anormale.

NEXT

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Procédures de tests (suite)

Procédure de test (suite) : Test du capteur de température

1- Alimenter le capteur tel qu'indiqué dans les fiches techniques pour que celui-ci soit capable d'indiquer des valeurs autant positives que négatives.

2- Calibrer une sonde d'oscilloscope.

3- Brancher la sonde d'oscilloscope à la patte Vout du capteur.

4- À l'aide d'un multimètre possédant une sonde de température, vérifier si le capteur réagit bien comme il est inscrit sur les fiches techniques du fabriquant. Pour de meilleur résultat, le capteur de température et la sonde du multimètre doivent être attaché ensemble pour ne pas qu'il y est d'écart de température lors des tests.

5- Tester le capteur sous des conditions au-dessus de zéro, dans les environs de 0°C, et inférieur à 0°C.

Résultats du test : Test du capteur de température

1- Comme résultat de ce test, il est véridique que le capteur réagit avec 10mV par °C. Il a aussi été vérifié que la tension à 0°C correspond bien à 0V. Le capteur a été testé dans les températures négatives jusqu'à -8°C, ceci étant la température du congélateur dans lequel fut testé ce capteur. Comme le capteur a bien fonctionner jusqu'à cette température, il a été extrapolé que celui-ci continuerait de bien fonctionner jusqu'à des températures égale ou inférieure à -10°C.

2- Les résultats de l'expérimentation n'ont pas été consignés ici, dû au fait que la température lors de test est en constant changement, mais il a été vérifié que les tensions à la sortie du capteur restaient dans les normes du fabriquant. Par exemple, à 25°C, la tension à la patte Vout était ¡5mV du résultat théorique de 250 mV. (25°C * 10mV/°C = 250 mV)

3- Pour ce projet les tensions à mesurer sont de -10°C à 40°C, ce qui donne donc des tensions de sorties entre -100mV et 400 mV.

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Procédures de tests (suite)

suite...procédures de test

Procédure de test : Test du détecteur de passage

1- Alimenter le détecteur à 5V.

2- Vérifier la différence de potentiel qui se crée lorsque le signal lumineux émis par le détecteur est coupé.

Résultats du test : Test du détecteur de passage

1- Une fois le détecteur alimenté, une plaque réfléchissante doit être installée pour permettre le retour du signal lumineux vers sa source. Quant le signal lumineux est réfléchi correctement vers sa source, un DEL s'allume pour indiquer que le signal revient vers sa source.

2- La tension aux bornes du détecteur est de passe de 0V à 250 mV quand le signal est coupé.

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Procédures de tests (suite)

suite...procédures de test

Procédure de test : Test de l'amplificateur du capteur de température

1- Alimenter le circuit

2- Calibrer les sondes d'oscilloscope

3- Vérifier l'alimentation des composantes.

4- Ajuster le " offset " (PT 2) à 0V.

5- Ajuster le gain à 10.

6- Ajuster le " offset " à 1V.

Résultats du test : Test de l'amplificateur du capteur de température

1- Pour ajuster le " offset " à 0V, il faut d'abord connecter l'entrée du capteur de température (patte 5) au ground, ensuite, placé une sonde d'oscilloscope au PT 2 ainsi qu'au PT 3.

2- Tourner le potentiomètre connecté à la patte 12 du MC4741 jusqu'à ce qu'une tension nulle apparaisse à l'écran de l'oscilloscope pour les deux ondes.

3- Pour ajuster le gain à 10, une sonde d'oscilloscope doit être connectée au PT 1 et une autre au PT 3. Mettre une tension inférieure à 1V à l'entrée du capteur de température (patte 5).

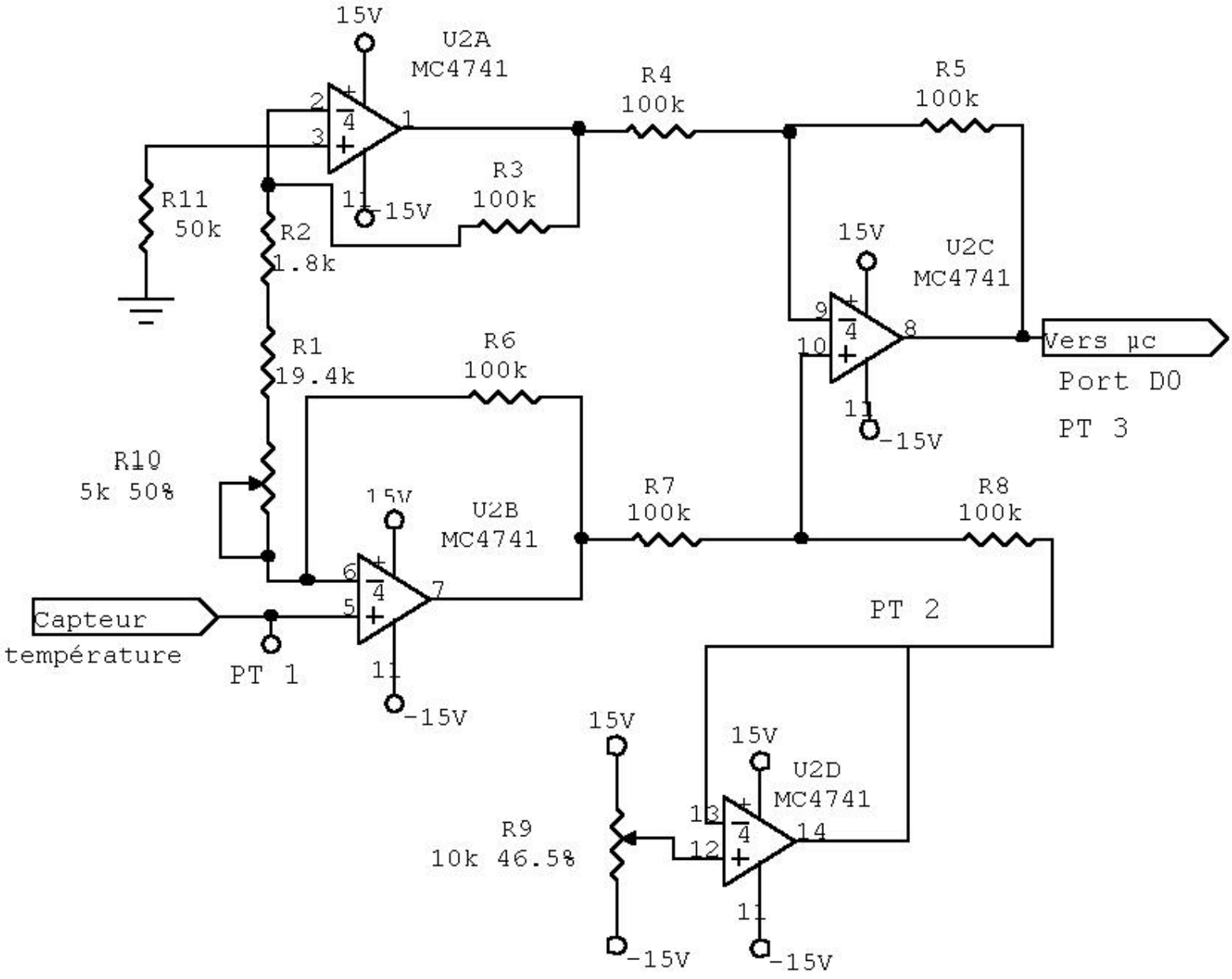
4- Ensuite, tourner le potentiomètre connecté à la patte 6 jusqu'à ce que la tension lue au PT 3 soit dix fois plus grande que celle lu au PT 1.

5- Pour ajuster le " offset " à 1V, il faut d'abord connecter l'entrée du capteur de température (patte 5) au ground, ensuite, placé une sonde d'oscilloscope au PT 2 ainsi qu'au PT 3.

6- Tourner le potentiomètre connecté à la patte 12 du MC4741 jusqu'à ce qu'une tension de 1V apparaisse à l'écran de l'oscilloscope pour le PT 2, et une tension correspondant à 10 fois l'entrée (patte 5) plus 1V au PT 3.

Amplificateur de température

NEXT


15V
U2A
MC4741
R4
100k
R5
100k
R3
100k
R11
50k
R2
1.8k
-15V
15V
U2C
MC4741
Vers µc
Port D0
PT 3
R1
19.4k
R6
100k
-15V
R10
5k 50%
15V
U2B
MC4741
R7
100k
R8
100k
Capteur
température
PT 1
PT 2
-15V
15V
15V
U2D
MC4741
R9
10k 46.5%
-15V
-15V

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Procédures de tests (suite)

suite...procédures de test

Procédures de test :

Les lignes qui suivent explique les caractéristiques des broches utilisées pour le fonctionnement du micro-contrôleur MC-68705R3, du UART HD-6402. Ces explications permettent d'effectuer les tests nécessaires afin de s'assurer que le traitement des données se fera correctement.Il s'agit de mesurer ,à l'aide d'un multimètre ou d'un oscilloscope, la tension sur chacune de ces broches.

Tests sur le micro-contrôleur MC-68705R3 :

Vérifier les niveaux de tension sur les broches Vcc (pin.4) et Vpp (pin.7) du micro-contrôleur. La tension devrait être de +5 volts DC.

Vérifier l'état du Vss (pin.1). Cette broche agit comme " ground ".

Sur les broches EXTAL (pin.5) et XTAL (pin.6), vérifier la fréquence d'oscillation. L'oscillation devrait être d'environ 4.5 MHz.

Mesurer sur ces broches :

PC2 (pin.11) : alimente l'avertisseur sonore. Un niveau de tension de +5 volts fait sonner l'avertisseur. Un niveau de tension de 0 volts laisse l'avertisseur en attente.

PC1 (pin.10) : alimente le LED#2. Ce voyant lumineux vert indique que le micro-contrôleur est en état de fonctionnement.

PC9 (pin.9) : alimente le LED#1. Ce voyant lumineux rouge indique que le micro-contrôleur n'est pas en état de fonctionner.

Registre de donnée du capteur magnétique: voir le manuel TOCCI p.159.

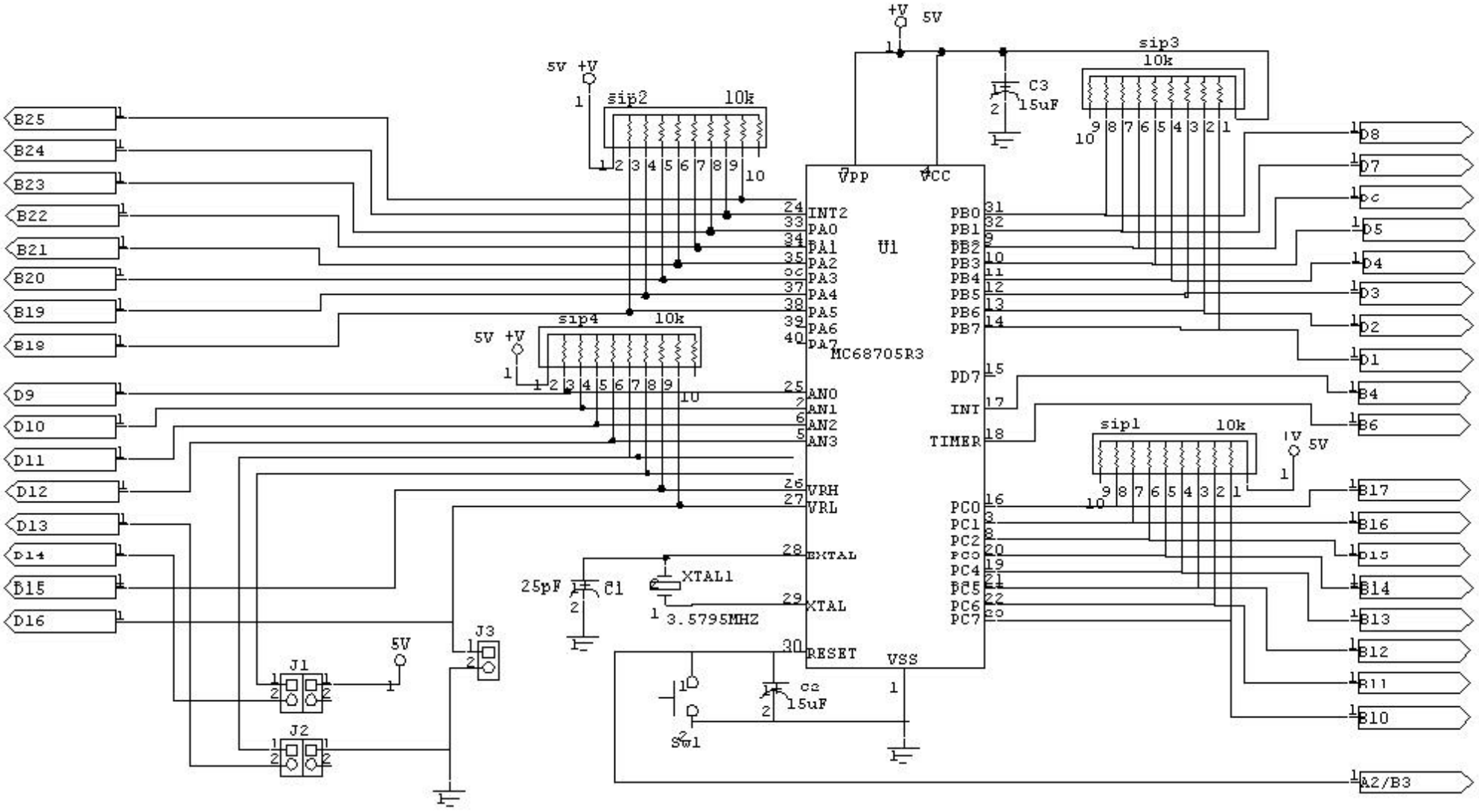
PA7 (pin.40) et PA4 (pin.37) : Ces commandes sont les " reset " du capteur infra-rouge et magnétique. Le micro-contrôleur envoie une impulsion au registre concerné afin de le réinitialiser.

PB0 (pin.25) à PB7 (pin.32) : port de réception et de transmission du micro-contrôleur.

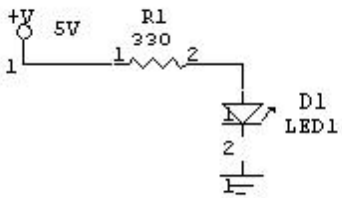
PDO/ANO (pin.24) : Cette broche converti l'information analogique reçue en format numérique.

micro-contrôleur

NEXT



Indicateur d'alimentation



J1: Sert à sélectionner si PD5 est une entrée ou branché sur VRL(GND)

J2: Sert à sélectionner si PD4 est une entrée ou branché sur VRH(+5V)

J3: Entrée (gnd/+5) servant à identifier le mode d'opération (e.i. Maitre/Esclave)

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Procédures de tests suite

suite...procédures de test

Procédures de test du UART HD-6402 :

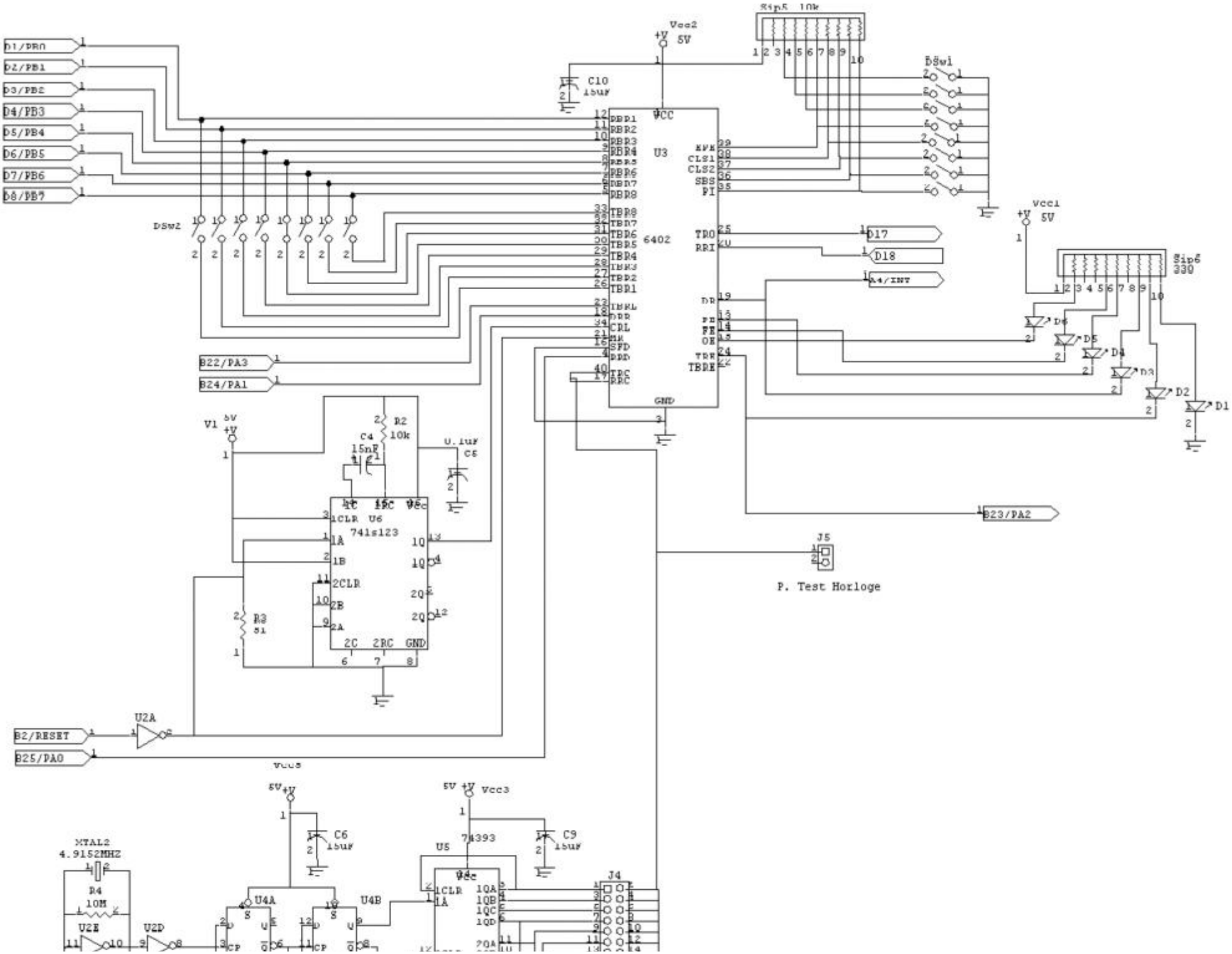
Vérifier la tension d'entrée sur la broche Vcc (pin.1) du UART. La tension devrait être de +5 volts.

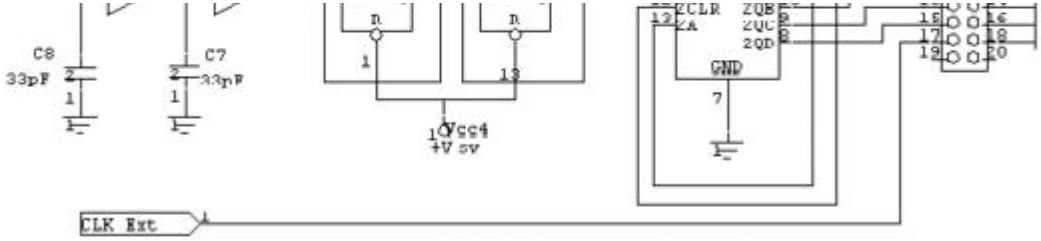
La broche GND (pin.3) devrait être à 0 volt.

/TBRL (pin.23) : Un niveau bas (0 volt) sur la broche /TBRL transfert l'information provenant des entrées TBR1 (pin.26) à TBR8 (pin.33). Le passage d'un niveau bas vers un niveau haut initialise le registre de transmission du UART.

TRE (pin.24): Un niveau haut (+5 volts) sur TRE indique que le registre est vide et que la transmission est compléter.

UART


D1/PB0
D2/PB1
D3/PB2
D4/PB3
D5/PB4
D6/PB5
D7/PB6
D8/PB7
DSW2
B22/PA3
B24/PA1
B2/RESET
B25/PA0
B23/PA2
U3
6402
Vcc2
+V 5V
C10
15uF
Sip5 10k
DSW1
Vcc1
Sip6 330
D17
D18
D6
D5
D4
D3
D2
D1
V1 5V
R2
10k
C4
15nF
0.1uF
C5
U6
74ls123
R3
5i
U2A
J5
P. Test Horloge
Vcc3
XTAL2
4.9152MHZ
R4
10M
U2E
U2D
C6
15uF
U4A
U4B
U5
74393
C9
15uF
J4
GND



Circuit d'horloge du UART

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Installation

MATÉRIEL REQUIS:

- 1 kit LMKG série 2001
- Ordinateur
- 1 tournevis étoile moyen

LISTE DES PIÈCES POUR UN KIT DE LMKG SÉRIE 2001

- 1 Boîtier
- 1 Bloc d'alimentation (+/-5Vdc +/- 12 V dc +/- 30 V dc)
- 1 Carte bus
- 1 Carte Contrôleur MC
- 1 Carte Communication série UART
- 1 Carte I/Oü 1 Carte interface rs-232
- 1 Carte win TV
- 1 Disquette
- 1 Avertisseur sonore
- 1 Capteur électromagnétique
- 1 Capteur de chaleur
- 1 Détecteur de mouvement
- 1 Mini-caméraü 1 Fil RCA
- 2 Transmetteurs à fibre optique
- 2 Récepteurs à fibre optique
- 2 Fibres optiques ü 1 Plaque réfléchissante
- 1 Sac de vis

PROCÉDURE D'INSTALLATION

1. Déballer les pièces et vérifiez la liste.
2. Fixer le bloc d'alimentation et alimenter la carte bus à +5V dc et +/-15 V dc, le détecteur de mouvement à +/-30 V dc, les transmetteurs et récepteurs à 5V dc et le RS-232 à+5V dc.
3. Alimenter la mini-caméra 120V ac.
4. Installer la " Carte Contrôleur MC " dans la fente MC de la carte Bus.
5. Installer la " Carte Communication série UART " dans la fente COM de la carte Bus.
6. Installer la " Carte I/O " dans une des fente I/O de la carte Bus
7. Installer la " Carte interface RS-232 " à l'arrière de l'ordinateur sur un port série libre.

Mini-caméra

1. Avant d'installer la carte Win TV mettre le PC hors tension.
2. Toucher le châssis du PC avec la main pour décharger de toute électricité statique, avant de sortir la carte de son emballage.
3. Insérer la carte Win TV dans le connecteur PCI disponible(connecteur bu- master PCI).Il est important que Windows 95/98 soit installé.
4. Pour installer la caméra, il suffit de raccorder la prise RCA(vidéo)de la caméra à la prise RCA de la carte Win TV dans le PC.
5. Alimenter la caméra à l'aide du bloc d'alimentation fourni.
6. Ouvrir le programme hauppauge,Win TV 32.

Avertisseur sonore

1.L'alimentation de l'avertisseur sonore est sur la carte I/O (5 Vdc)
2.Installer l'avertisseur prêt de l'objet à protéger.

Capteur de chaleur

1.Alimenter à 5Vdc+mise à la terre..
2.Installer la capteur de chaleur dans le centre de la pièce pour avoir une meilleur température d'ensemble.

Capteur électromagnétique

1.Alimenter 5 Vdc +mise à la terre.
2.Installer le capteur sous l'objet.

Détecteur de mouvement

1.Alimenter à 30Vdc +mise à la terre.
2.Installer le détecteur de mouvement devant l'objet a protéger et installer la plaque réfléchissante devant l'objectif.

Module transmission et de réception à fibre optique

1.Toujours installer les deux connecteurs au module à fibre optique avant d'alimenter les modules, pour la transmission et la réception.
2.Ne jamais regarder dedans la fibre si elle est allimentée.
3.Alimenter le premier module à 5 Vdc + la mise à la terre.
4.Installer le module 1 prêt du boiter du système d'alarme.
5.Alimenter le module2 à 5 Vdc +la mise à la terre.
6.Installer l e module 2 prêt du PC et installer entré et la sortie du module au RS-232.

Programme principale

1.Insérer la disquette du programme principale dans le lecteur A.
2.Aller dans le poste de travail, double click sur disquette A et double click sur install Ce programme crée un icône sur le bureau et copie les fichiers dans l'ordinateur.
3..Exécuter le programme.
4.Choisisser votre code d'accès et un nom d'utilisateur. 7. Relier avec le câble coaxiale de 20 cm la carte Communication RF 916 MHz au connecteur du boîtier. 8. Fermer le couvercle & connectez l'antenne sur le connecteur du boîtier 9. Brancher les senseurs, sonde, actionneur etc. sur la carte I/O

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Référence

Voici une liste de référence de divers composantes du projet.

le max-232

le UART

Les ampli de la cartes I/O

Capteur de température

Module de transmission et de réception de la fibre optique

Micro-contrôleur 68705 R3

Les noirs des circuits

La liste des pièces

19-4323; Rev 9; 4/00

MAXIM

+5V-Powered, Multichannel RS-232 Drivers/Receivers

General Description

The MAX220–MAX249 family of line drivers/receivers is intended for all EIA/TIA-232E and V.28/V.24 communications interfaces, particularly applications where ±12V is not available.

These parts are especially useful in battery-powered systems, since their low-power shutdown mode reduces power dissipation to less than 5µW. The MAX225, MAX233, MAX235, and MAX245/MAX246/MAX247 use no external components and are recommended for applications where printed circuit board space is critical.

Applications

Portable Computers

Low-Power Modems

Interface Translation

Battery-Powered RS-232 Systems

Multidrop RS-232 Networks

Features

Superior to Bipolar

- **Operate from Single +5V Power Supply (+5V and +12V—MAX231/MAX239)**
- **Low-Power Receive Mode in Shutdown (MAX223/MAX242)**
- **Meet All EIA/TIA-232E and V.28 Specifications**
- **Multiple Drivers and Receivers**
- **3-State Driver and Receiver Outputs**
- **Open-Line Detection (MAX243)**

Ordering Information

PART	TEMP. RANGE	PIN-PACKAGE
MAX220CPE	0°C to +70°C	16 Plastic DIP
MAX220CSE	0°C to +70°C	16 Narrow SO
MAX220CWE	0°C to +70°C	16 Wide SO
MAX220C/D	0°C to +70°C	Dice*
MAX220EPE	-40°C to +85°C	16 Plastic DIP
MAX220ESE	-40°C to +85°C	16 Narrow SO
MAX220EWE	-40°C to +85°C	16 Wide SO
MAX220EJE	-40°C to +85°C	16 CERDIP
MAX220MJE	-55°C to +125°C	16 CERDIP

Ordering Information continued at end of data sheet.

**Contact factory for dice specifications.*

Selection Table

Part Number	Power Supply (V)	No. of RS-232 Drivers/Rx	No. of Ext. Caps	Nominal Cap. Value (µF)	SHDN & Three-State	Rx Active in SHDN	Data Rate (kbps)	Features
MAX220	+5	2/2	4	4.7/10	No	—	120	Ultra-low-power, industry-standard pinout
MAX222	+5	2/2	4	0.1	Yes	—	200	Low-power shutdown
MAX223 (MAX213)	+5	4/5	4	1.0 (0.1)	Yes	✔	120	MAX241 and receivers active in shutdown
MAX225	+5	5/5	0	—	Yes	✔	120	Available in SO
MAX230 (MAX200)	+5	5/0	4	1.0 (0.1)	Yes	—	120	5 drivers with shutdown
MAX231 (MAX201)	+5 and +7.5 to +13.2	2/2	2	1.0 (0.1)	No	—	120	Standard +5/+12V or battery supplies; same functions as MAX232
MAX232 (MAX202)	+5	2/2	4	1.0 (0.1)	No	—	120 (64)	Industry standard
MAX232A	+5	2/2	4	0.1	No	—	200	Higher slew rate, small caps
MAX233 (MAX203)	+5	2/2	0	—	No	—	120	No external caps
MAX233A	+5	2/2	0	—	No	—	200	No external caps, high slew rate
MAX234 (MAX204)	+5	4/0	4	1.0 (0.1)	No	—	120	Replaces 1488
MAX235 (MAX205)	+5	5/5	0	—	Yes	—	120	No external caps
MAX236 (MAX206)	+5	4/3	4	1.0 (0.1)	Yes	—	120	Shutdown, three state
MAX237 (MAX207)	+5	5/3	4	1.0 (0.1)	No	—	120	Complements IBM PC serial port
MAX238 (MAX208)	+5	4/4	4	1.0 (0.1)	No	—	120	Replaces 1488 and 1489
MAX239 (MAX209)	+5 and +7.5 to +13.2	3/5	2	1.0 (0.1)	No	—	120	Standard +5/+12V or battery supplies; single-package solution for IBM PC serial port
MAX240	+5	5/5	4	1.0	Yes	—	120	DIP or flatpack package
MAX241 (MAX211)	+5	4/5	4	1.0 (0.1)	Yes	—	120	Complete IBM PC serial port
MAX242	+5	2/2	4	0.1	Yes	✔	200	Separate shutdown and enable
MAX243	+5	2/2	4	0.1	No	—	200	Open-line detection simplifies cabling
MAX244	+5	8/10	4	1.0	No	—	120	High slew rate
MAX245	+5	8/10	0	—	Yes	✔	120	High slew rate, int. caps, two shutdown modes
MAX246	+5	8/10	0	—	Yes	✔	120	High slew rate, int. caps, three shutdown modes
MAX247	+5	8/9	0	—	Yes	✔	120	High slew rate, int. caps, nine operating modes
MAX248	+5	8/8	4	1.0	Yes	✔	120	High slew rate, selective half-chip enables
MAX249	+5	6/10	4	1.0	Yes	✔	120	Available in quad flatpack package

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+5V-Powered, Multichannel RS-232 Drivers/Receivers

ABSOLUTE MAXIMUM RATINGS—MAX220/222/232A/233A/242/243

Supply Voltage (V_{CC}) .....-0.3V to +6V
Input Voltages
T_{IN}.....-0.3V to (V_{CC} - 0.3V)
R_{IN} (Except MAX220) .....±30V
R_{IN} (MAX220).....±25V
T_{OUT} (Except MAX220) (Note 1) .....±15V
T_{OUT} (MAX220).....±13.2V
Output Voltages
T_{OUT}.....±15V
R_{OUT}.....-0.3V to (V_{CC} + 0.3V)
Driver/Receiver Output Short Circuited to GND.....Continuous
Continuous Power Dissipation (T_A = +70°C)
16-Pin Plastic DIP (derate 10.53mW/°C above +70°C)....842mW
18-Pin Plastic DIP (derate 11.11mW/°C above +70°C)....889mW
20-Pin Plastic DIP (derate 8.00mW/°C above +70°C) ..440mW
16-Pin Narrow SO (derate 8.70mW/°C above +70°C) ...696mW
16-Pin Wide SO (derate 9.52mW/°C above +70°C).....762mW
18-Pin Wide SO (derate 9.52mW/°C above +70°C).....762mW
20-Pin Wide SO (derate 10.00mW/°C above +70°C)....800mW
20-Pin SSOP (derate 8.00mW/°C above +70°C) 640mW
16-Pin CERDIP (derate 10.00mW/°C above +70°C).....800mW
18-Pin CERDIP (derate 10.53mW/°C above +70°C).....842mW
Operating Temperature Ranges
MAX2_ _AC_ _, MAX2_ _C_ _.....0°C to +70°C
MAX2_ _AE_ _, MAX2_ _E_ _ .....-40°C to +85°C
MAX2_ _AM_ _, MAX2_ _M_ _.....-55°C to +125°C
Storage Temperature Range .....-65°C to +160°C
Lead Temperature (soldering, 10sec) .....+300°C

Note 1: Input voltage measured with T_{OUT} in high-impedance state, $\overline{SHDN}$ or V_{CC} = 0V.
Note 2: For the MAX220, V+ and V- can have a maximum magnitude of 7V, but their absolute difference cannot exceed 13V.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS—MAX220/222/232A/233A/242/243

(V_{CC} = +5V ±10%, C1–C4 = 0.1µF, MAX220, C1 = 0.047µF, C2–C4 = 0.33µF, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
RS-232 TRANSMITTERS						
Output Voltage Swing	All transmitter outputs loaded with 3kΩ to GND		±5	±8		V
Input Logic Threshold Low				1.4	0.8	V
Input Logic Threshold High	All except MAX220		2	1.4		V
	MAX220: V_{CC} = 5.0V		2.4			
Logic Pull-Up/Input Current	All except MAX220, normal operation			5	40	µA
	$\overline{SHDN}$ = 0V, MAX222/242, shutdown, MAX220			±0.01	±1	
Output Leakage Current	V_{CC} = 5.5V, $\overline{SHDN}$ = 0V, V_{OUT} = ±15V, MAX222/242			±0.01	±10	µA
	V_{CC} = $\overline{SHDN}$ = 0V, V_{OUT} = ±15V			±0.01	±10	
Data Rate	All except MAX220, normal operation			200	116	kb/s
Transmitter Output Resistance	V_{CC} = V+ = V- = 0V, V_{OUT} = ±2V		300	10M		Ω
Output Short-Circuit Current	V_{OUT} = 0V		±7	±22		mA
RS-232 RECEIVERS						
RS-232 Input Voltage Operating Range					±30	V
RS-232 Input Threshold Low	V_{CC} = 5V	All except MAX243 $R2_{IN}$	0.8	1.3		V
		MAX243 $R2_{IN}$ (Note 2)	-3			
RS-232 Input Threshold High	V_{CC} = 5V	All except MAX243 $R2_{IN}$		1.8	2.4	V
		MAX243 $R2_{IN}$ (Note 2)		-0.5	-0.1	
RS-232 Input Hysteresis	All except MAX243, V_{CC} = 5V, no hysteresis in shdn.		0.2	0.5	1	V
	MAX243			1		
RS-232 Input Resistance			3	5	7	kΩ
TTL/CMOS Output Voltage Low	I_{OUT} = 3.2mA			0.2	0.4	V
TTL/CMOS Output Voltage High	I_{OUT} = -1.0mA		3.5	V_{CC} - 0.2		V
TTL/CMOS Output Short-Circuit Current	Sourcing V_{OUT} = GND		-2	-10		mA
	Shrinking V_{OUT} = V_{CC}		10	30		

ELECTRICAL CHARACTERISTICS—MAX220/222/232A/233A/242/243 (continued)

(V_{CC} = +5V ±10%, C1–C4 = 0.1µF, MAX220, C1 = 0.047µF, C2–C4 = 0.33µF, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
TTL/CMOS Output Leakage Current	$\overline{SHDN}$ = V_{CC} or $\overline{EN}$ = V_{CC} ($\overline{SHDN}$ = 0V for MAX222), 0V ≤ V_{OUT} ≤ V_{CC}			±0.05	±10	µA
$\overline{EN}$ Input Threshold Low	MAX242			1.4	0.8	V
$\overline{EN}$ Input Threshold High	MAX242		2.0	1.4		V
Operating Supply Voltage			4.5		5.5	V
V_{CC} Supply Current ($\overline{SHDN}$ = V_{CC}), Figures 5, 6, 11, 19	No load	MAX220		0.5	2	mA
		MAX222/232A/233A/242/243		4	10	
	3kΩ load both inputs	MAX220		12		
		MAX222/232A/233A/242/243		15		
Shutdown Supply Current	MAX222/242	T_A = +25°C		0.1	10	µA
		T_A = 0°C to +70°C		2	50	
		T_A = -40°C to +85°C		2	50	
		T_A = -55°C to +125°C		35	100	
$\overline{SHDN}$ Input Leakage Current	MAX222/242				±1	µA
$\overline{SHDN}$ Threshold Low	MAX222/242			1.4	0.8	V
$\overline{SHDN}$ Threshold High	MAX222/242		2.0	1.4		V
Transition Slew Rate	C_L = 50pF to 2500pF, R_L = 3kΩ to 7kΩ, V_{CC} = 5V, T_A = +25°C, measured from +3V to -3V or -3V to +3V	MAX222/232A/233A/242/243	6	12	30	V/µs
		MAX220	1.5	3	30	
Transmitter Propagation Delay TLL to RS-232 (normal operation), Figure 1	t_{PHLT}	MAX222/232A/233A/242/243		1.3	3.5	µs
		MAX220		4	10	
	t_{PLHT}	MAX222/232A/233A/242/243		1.5	3.5	
		MAX220		5	10	
Receiver Propagation Delay RS-232 to TLL (normal operation), Figure 2	t_{PHLR}	MAX222/232A/233A/242/243		0.5	1	µs
		MAX220		0.6	3	
	t_{PLHR}	MAX222/232A/233A/242/243		0.6	1	
		MAX220		0.8	3	
Receiver Propagation Delay RS-232 to TLL (shutdown), Figure 2	t_{PHLS}	MAX242		0.5	10	µs
	t_{PLHS}	MAX242		2.5	10	
Receiver-Output Enable Time, Figure 3	t_{ER}	MAX242		125	500	ns
Receiver-Output Disable Time, Figure 3	t_{DR}	MAX242		160	500	ns
Transmitter-Output Enable Time ($\overline{SHDN}$ goes high), Figure 4	t_{ET}	MAX222/242, 0.1µF caps (includes charge-pump start-up)		250		µs
Transmitter-Output Disable Time ($\overline{SHDN}$ goes low), Figure 4	t_{DT}	MAX222/242, 0.1µF caps		600		ns
Transmitter + to - Propagation Delay Difference (normal operation)	t_{PHLT} - t_{PLHT}	MAX222/232A/233A/242/243		300		ns
		MAX220		2000		
Receiver + to - Propagation Delay Difference (normal operation)	t_{PHLR} - t_{PLHR}	MAX222/232A/233A/242/243		100		ns
		MAX220		225		

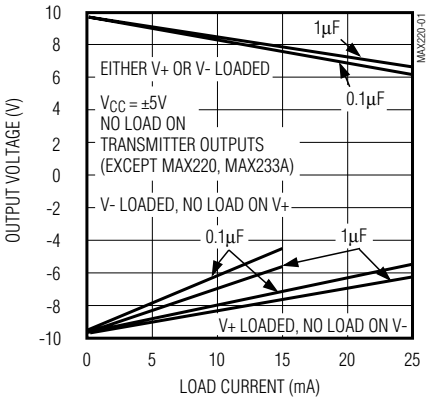
Note 3: MAX243 $R2_{OUT}$ is guaranteed to be low when $R2_{IN}$ is ≥ 0V or is floating.

+5V-Powered, Multichannel RS-232 Drivers/Receivers

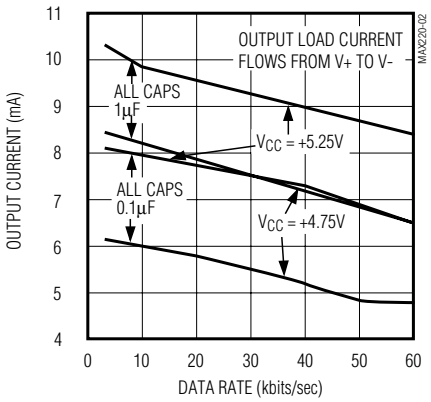
Typical Operating Characteristics

MAX220/MAX222/MAX232A/MAX233A/MAX242/MAX243

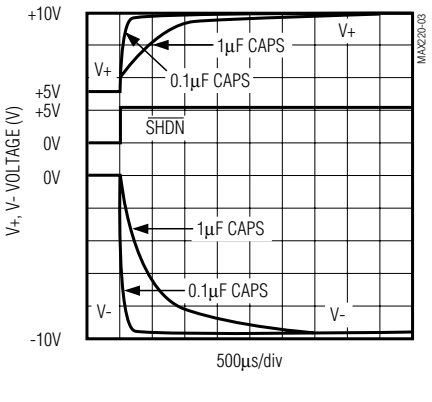
OUTPUT VOLTAGE vs. LOAD CURRENT



AVAILABLE OUTPUT CURRENT vs. DATA RATE



MAX222/MAX242 ON-TIME EXITING SHUTDOWN



ABSOLUTE MAXIMUM RATINGS—MAX223/MAX230–MAX241

V_{CC} .....-0.3V to +6V
V+ .....(V_{CC} - 0.3V) to +14V
V- .....+0.3V to -14V
Input Voltages
  T_{IN} .....-0.3V to (V_{CC} + 0.3V)
  R_{IN}.....±30V
Output Voltages
  T_{OUT} .....(V+ + 0.3V) to (V- - 0.3V)
  R_{OUT}.....-0.3V to (V_{CC} + 0.3V)
Short-Circuit Duration, T_{OUT} .....Continuous
Continuous Power Dissipation (T_A = +70°C)
  14-Pin Plastic DIP (derate 10.00mW/°C above +70°C)....800mW
  16-Pin Plastic DIP (derate 10.53mW/°C above +70°C)....842mW
  20-Pin Plastic DIP (derate 11.11mW/°C above +70°C)....889mW
  24-Pin Narrow Plastic DIP
    (derate 13.33mW/°C above +70°C) 1.07W
  24-Pin Plastic DIP (derate 9.09mW/°C above +70°C).....500mW
  16-Pin Wide SO (derate 9.52mW/°C above +70°C).....762mW
  20-Pin Wide SO (derate 10 00mW/°C above +70°C).....800mW
  24-Pin Wide SO (derate 11.76mW/°C above +70°C).....941mW
  28-Pin Wide SO (derate 12.50mW/°C above +70°C) 1W
  44-Pin Plastic FP (derate 11.11mW/°C above +70°C) 889mW
  14-Pin CERDIP (derate 9.09mW/°C above +70°C) 727mW
  16-Pin CERDIP (derate 10.00mW/°C above +70°C) 800mW
  20-Pin CERDIP (derate 11.11mW/°C above +70°C) 889mW
  24-Pin Narrow CERDIP
    (derate 12.50mW/°C above +70°C) 1W
  24-Pin Sidebraze (derate 20.0mW/°C above +70°C).....1.6W
  28-Pin SSOP (derate 9.52mW/°C above +70°C).....762mW
Operating Temperature Ranges
  MAX2 _ _ C _ _.....0°C to +70°C
  MAX2 _ _ E _ _.....-40°C to +85°C
  MAX2 _ _ M _ _ .....-55°C to +125°C
Storage Temperature Range .....-65°C to +160°C
Lead Temperature (soldering, 10sec) .....+300°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS—MAX223/MAX230–MAX241

(MAX223/230/232/234/236/237/238/240/241, V_{CC} = +5V ±10; MAX233/MAX235, V_{CC} = 5V ±5%, C1–C4 = 1.0µF; MAX231/MAX239, V_{CC} = 5V ±10%; V+ = 7.5V to 13.2V; T_A = T_{MIN} to T_{MAX}; unless otherwise noted.)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Output Voltage Swing	All transmitter outputs loaded with 3kΩ to ground		±5.0	±7.3		V
V_{CC} Power-Supply Current	No load, T_A = +25°C	MAX232/233		5	10	mA
		MAX223/230/234–238/240/241		7	15	
		MAX231/239		0.4	1	
V+ Power-Supply Current		MAX231		1.8	5	mA
		MAX239		5	15	
Shutdown Supply Current	T_A = +25°C	MAX223		15	50	µA
		MAX230/235/236/240/241		1	10	
Input Logic Threshold Low	T_{IN}; EN, $\overline{SHDN}$ (MAX233); $\overline{EN}$, SHDN (MAX230/235–241)				0.8	V
Input Logic Threshold High	T_{IN}		2.0			V
	EN, $\overline{SHDN}$ (MAX223); $\overline{EN}$, SHDN (MAX230/235/236/240/241)		2.4			
Logic Pull-Up Current	T_{IN} = 0V			1.5	200	µA
Receiver Input Voltage Operating Range			-30		30	V

+5V-Powered, Multichannel RS-232 Drivers/Receivers

ELECTRICAL CHARACTERISTICS—MAX223/MAX230–MAX241 (continued)

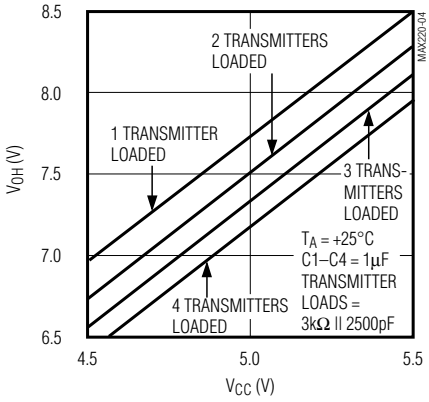
(MAX223/230/232/234/236/237/238/240/241, V_{CC} = +5V ±10; MAX233/MAX235, V_{CC} = 5V ±5%, C1–C4 = 1.0µF; MAX231/MAX239, V_{CC} = 5V ±10%; V+ = 7.5V to 13.2V; T_A = T_{MIN} to T_{MAX}; unless otherwise noted.)

PARAMETER	CONDITIONS			MIN	TYP	MAX	UNITS
RS-232 Input Threshold Low	T_A = +25°C, V_{CC} = 5V	Normal operation $\overline{SHDN}$ = 5V (MAX223) SHDN = 0V (MAX235/236/240/241)		0.8	1.2		V
		Shutdown (MAX223) $\overline{SHDN}$ = 0V, EN = 5V ($R4_{IN}$, $R5_{IN}$)		0.6	1.5		
RS-232 Input Threshold High	T_A = +25°C, V_{CC} = 5V	Normal operation $\overline{SHDN}$ = 5V (MAX223) SHDN = 0V (MAX235/236/240/241)			1.7	2.4	V
		Shutdown (MAX223) $\overline{SHDN}$ = 0V, EN = 5V ($R4_{IN}$, $R5_{IN}$)			1.5	2.4	
RS-232 Input Hysteresis	V_{CC} = 5V, no hysteresis in shutdown			0.2	0.5	1.0	V
RS-232 Input Resistance	T_A = +25°C, V_{CC} = 5V			3	5	7	kΩ
TTL/CMOS Output Voltage Low	I_{OUT} = 1.6mA (MAX231/232/233, I_{OUT} = 3.2mA)					0.4	V
TTL/CMOS Output Voltage High	I_{OUT} = -1mA			3.5	V_{CC} - 0.4		V
TTL/CMOS Output Leakage Current	0V ≤ R_{OUT} ≤ V_{CC}; EN = 0V (MAX223); $\overline{EN}$ = V_{CC} (MAX235–241)				0.05	±10	µA
Receiver Output Enable Time	Normal operation	MAX223			600		ns
		MAX235/236/239/240/241			400		
Receiver Output Disable Time	Normal operation	MAX223			900		ns
		MAX235/236/239/240/241			250		
Propagation Delay	RS-232 IN to TTL/CMOS OUT, C_L = 150pF	Normal operation			0.5	10	µs
		$\overline{SHDN}$ = 0V (MAX223)	t_{PHLS}		4	40	
			t_{PLHS}		6	40	
Transition Region Slew Rate	MAX223/MAX230/MAX234–241, T_A = +25°C, V_{CC} = 5V, R_L = 3kΩ to 7kΩ, C_L = 50pF to 2500pF, measured from +3V to -3V or -3V to +3V			3	5.1	30	V/µs
	MAX231/MAX232/MAX233, T_A = +25°C, V_{CC} = 5V, R_L = 3kΩ to 7kΩ, C_L = 50pF to 2500pF, measured from +3V to -3V or -3V to +3V				4	30	
Transmitter Output Resistance	V_{CC} = V+ = V- = 0V, V_{OUT} = ±2V			300			Ω
Transmitter Output Short-Circuit Current					±10		mA

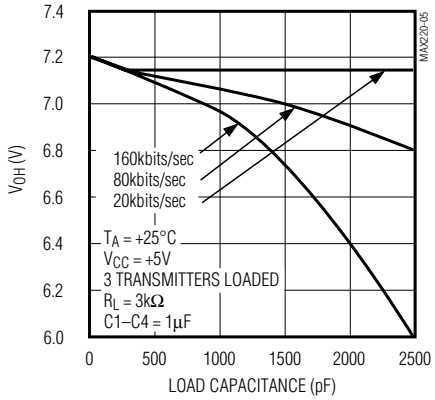
Typical Operating Characteristics

MAX223/MAX230–MAX241

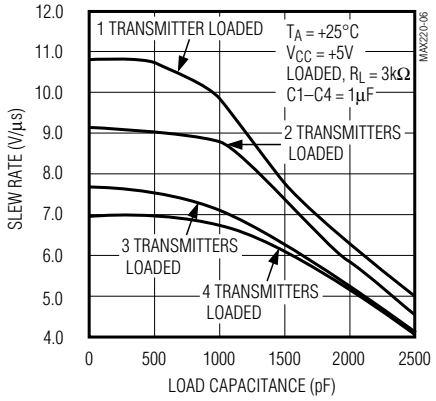
TRANSMITTER OUTPUT VOLTAGE (V_{OH}) vs. V_{CC}



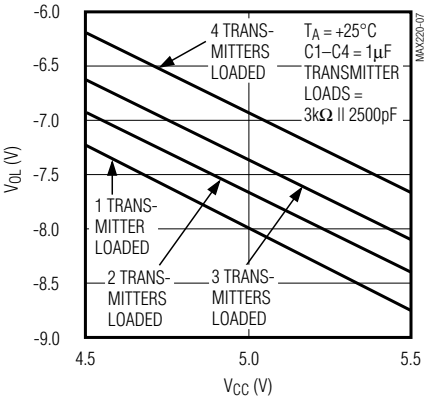
TRANSMITTER OUTPUT VOLTAGE (V_{OH}) vs. LOAD CAPACITANCE AT DIFFERENT DATA RATES



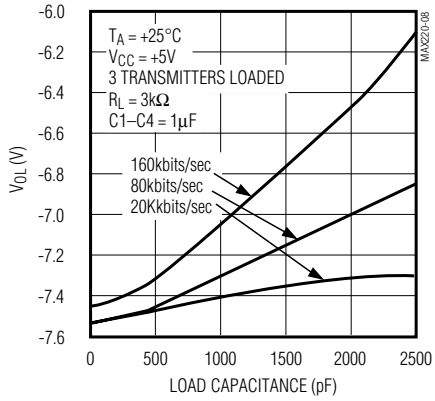
TRANSMITTER SLEW RATE vs. LOAD CAPACITANCE



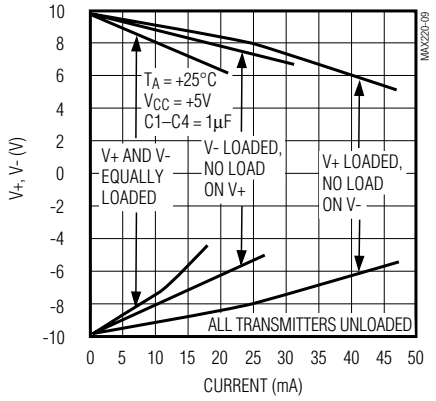
TRANSMITTER OUTPUT VOLTAGE (V_{OL}) vs. V_{CC}



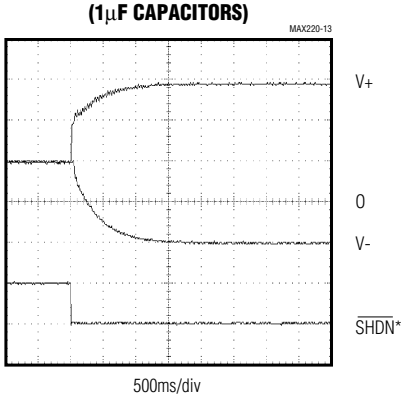
TRANSMITTER OUTPUT VOLTAGE (V_{OL}) vs. LOAD CAPACITANCE AT DIFFERENT DATA RATES



TRANSMITTER OUTPUT VOLTAGE (V+, V-) vs. LOAD CURRENT



V+, V- WHEN EXITING SHUTDOWN (1µF CAPACITORS)



*SHUTDOWN POLARITY IS REVERSED FOR NON MAX241 PARTS

+5V-Powered, Multichannel RS-232 Drivers/Receivers

ABSOLUTE MAXIMUM RATINGS—MAX225/MAX244–MAX249

Supply Voltage (V_{CC}) .....-0.3V to +6V
Input Voltages
T_{IN}, $\overline{ENA}$, $\overline{ENB}$, $\overline{ENR}$, $\overline{ENT}$, $\overline{ENRA}$, $\overline{ENRB}$, $\overline{ENTA}$, $\overline{ENTB}$.....-0.3V to (V_{CC} + 0.3V)
R_{IN} .....±25V
T_{OUT} (Note 3).....±15V
R_{OUT} .....-0.3V to (V_{CC} + 0.3V)
Short Circuit (one output at a time)
T_{OUT} to GND.....Continuous
R_{OUT} to GND.....Continuous

Continuous Power Dissipation (T_A = +70°C)
28-Pin Wide SO (derate 12.50mW/°C above +70°C) 1W
40-Pin Plastic DIP (derate 11.11mW/°C above +70°C) ...611mW
44-Pin PLCC (derate 13.33mW/°C above +70°C) 1.07W
Operating Temperature Ranges
MAX225C_ _, MAX24_C_ _ .....0°C to +70°C
MAX225E_ _, MAX24_E_ _ .....-40°C to +85°C
Storage Temperature Range .....-65°C to +160°C
Lead Temperature (soldering,10sec) .....+300°C

Note 4: Input voltage measured with transmitter output in a high-impedance state, shutdown, or V_{CC} = 0V.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS—MAX225/MAX244–MAX249

(MAX225, V_{CC} = 5.0V ±5%; MAX244–MAX249, V_{CC} = +5.0V ±10%, external capacitors C1–C4 = 1µF; T_A = T_{MIN} to T_{MAX}; unless otherwise noted.)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
RS-232 TRANSMITTERS						
Input Logic Threshold Low				1.4	0.8	V
Input Logic Threshold High			2	1.4		V
Logic Pull-Up/Input Current	Tables 1a–1d	Normal operation		10	50	µA
		Shutdown		±0.01	±1	
Data Rate	Tables 1a–1d, normal operation			120	64	kbits/sec
Output Voltage Swing	All transmitter outputs loaded with 3kΩ to GND		±5	±7.5		V
Output Leakage Current (shutdown)	Tables 1a–1d	$\overline{ENA}$, $\overline{ENB}$, $\overline{ENT}$, $\overline{ENTA}$, $\overline{ENTB}$ = V_{CC}, V_{OUT} = ±15V		±0.01	±25	µA
		V_{CC} = 0V, V_{OUT} = ±15V		±0.01	±25	
Transmitter Output Resistance	V_{CC} = V+ = V- = 0V, V_{OUT} = ±2V (Note 4)		300	10M		Ω
Output Short-Circuit Current	V_{OUT} = 0V		±7	±30		mA
RS-232 RECEIVERS						
RS-232 Input Voltage Operating Range					±25	V
RS-232 Input Threshold Low	V_{CC} = 5V		0.8	1.3		V
RS-232 Input Threshold High	V_{CC} = 5V			1.8	2.4	V
RS-232 Input Hysteresis	V_{CC} = 5V		0.2	0.5	1.0	V
RS-232 Input Resistance			3	5	7	kΩ
TTL/CMOS Output Voltage Low	I_{OUT} = 3.2mA			0.2	0.4	V
TTL/CMOS Output Voltage High	I_{OUT} = -1.0mA		3.5	V_{CC} - 0.2		V
TTL/CMOS Output Short-Circuit Current	Sourcing V_{OUT} = GND		-2	-10		mA
	Shrinking V_{OUT} = V_{CC}		10	30		
TTL/CMOS Output Leakage Current	Normal operation, outputs disabled, Tables 1a–1d, 0V ≤ V_{OUT} ≤ V_{CC}, $\overline{ENR}$_ = V_{CC}			±0.05	±0.10	µA

ELECTRICAL CHARACTERISTICS—MAX225/MAX244–MAX249 (continued)

(MAX225, V_{CC} = 5.0V ±5%; MAX244–MAX249, V_{CC} = +5.0V ±10%, external capacitors C1–C4 = 1µF; T_A = T_{MIN} to T_{MAX}; unless otherwise noted.)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
POWER SUPPLY AND CONTROL LOGIC						
Operating Supply Voltage		MAX225	4.75		5.25	V
		MAX244–MAX249	4.5		5.5	
V_{CC} Supply Current (normal operation)	No load	MAX225		10	20	mA
		MAX244–MAX249		11	30	
	3kΩ loads on all outputs	MAX225		40		
		MAX244–MAX249		57		
Shutdown Supply Current	T_A = +25°C			8	25	µA
	T_A = T_{MIN} to T_{MAX}				50	
Control Input	Leakage current				±1	µA
	Threshold low			1.4	0.8	V
	Threshold high		2.4	1.4		
AC CHARACTERISTICS						
Transition Slew Rate	C_L = 50pF to 2500pF, R_L = 3kΩ to 7kΩ, V_{CC} = 5V, T_A = +25°C, measured from +3V to -3V or -3V to +3V		5	10	30	V/µs
Transmitter Propagation Delay TLL to RS-232 (normal operation), Figure 1	t_{PHLT}			1.3	3.5	µs
	t_{PLHT}			1.5	3.5	
Receiver Propagation Delay TLL to RS-232 (normal operation), Figure 2	t_{PHLR}			0.6	1.5	µs
	t_{PLHR}			0.6	1.5	
Receiver Propagation Delay TLL to RS-232 (low-power mode), Figure 2	t_{PHLS}			0.6	10	µs
	t_{PLHS}			3.0	10	
Transmitter + to - Propagation Delay Difference (normal operation)	t_{PHLT} - t_{PLHT}			350		ns
Receiver + to - Propagation Delay Difference (normal operation)	t_{PHLR} - t_{PLHR}			350		ns
Receiver-Output Enable Time, Figure 3	t_{ER}			100	500	ns
Receiver-Output Disable Time, Figure 3	t_{DR}			100	500	ns
Transmitter Enable Time	t_{ET}	MAX246–MAX249 (excludes charge-pump start-up)		5		µs
		MAX225/MAX245–MAX249 (includes charge-pump start-up)		10		ms
Transmitter Disable Time, Figure 4	t_{DT}			100		ns

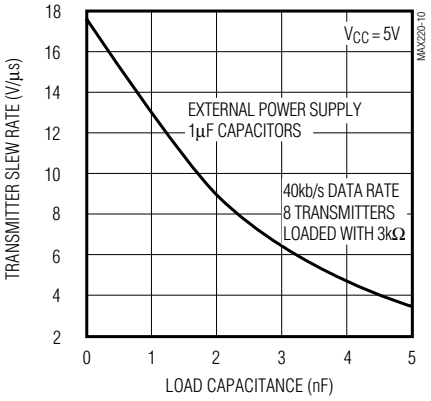
Note 5: The 300Ω minimum specification complies with EIA/TIA-232E, but the actual resistance when in shutdown mode or V_{CC} = 0V is 10MΩ as is implied by the leakage specification.

+5V-Powered, Multichannel RS-232 Drivers/Receivers

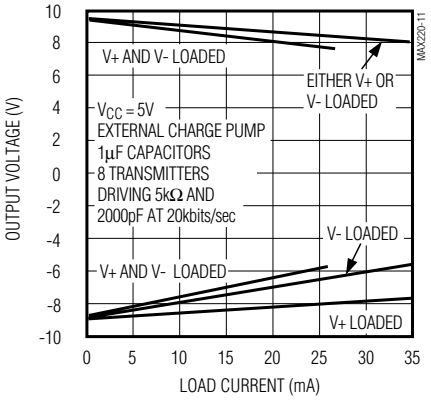
Typical Operating Characteristics

MAX225/MAX244–MAX249

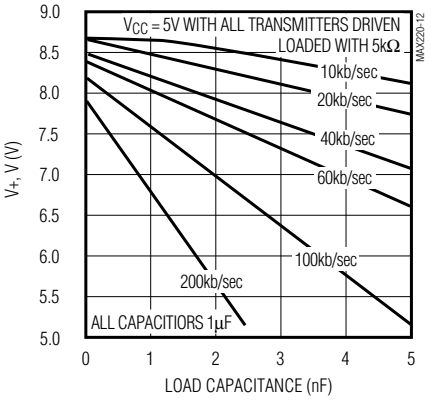
TRANSMITTER SLEW RATE vs. LOAD CAPACITANCE



OUTPUT VOLTAGE vs. LOAD CURRENT FOR V+ AND V-



TRANSMITTER OUTPUT VOLTAGE (V+, V-) vs. LOAD CAPACITANCE AT DIFFERENT DATA RATES



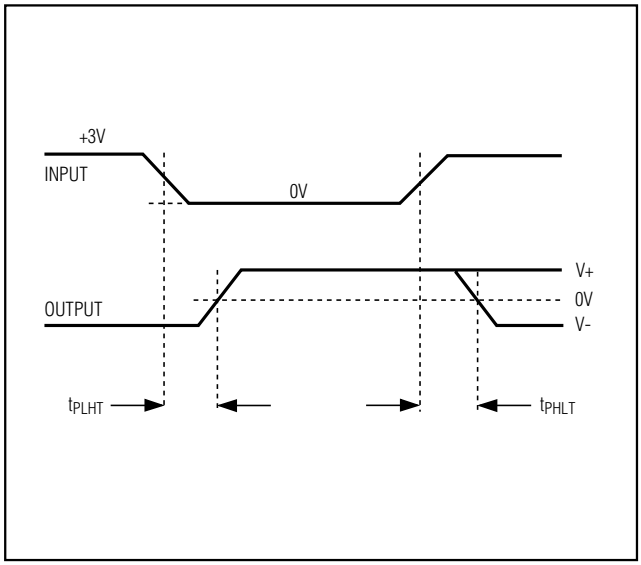


Figure 1. Transmitter Propagation-Delay Timing

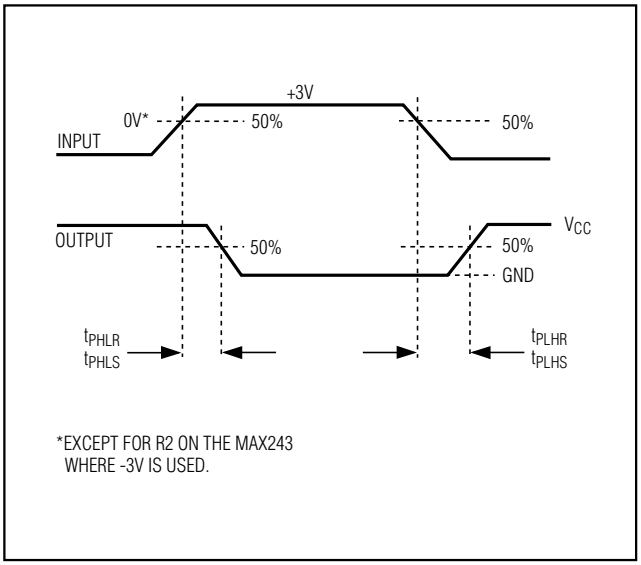


Figure 2. Receiver Propagation-Delay Timing

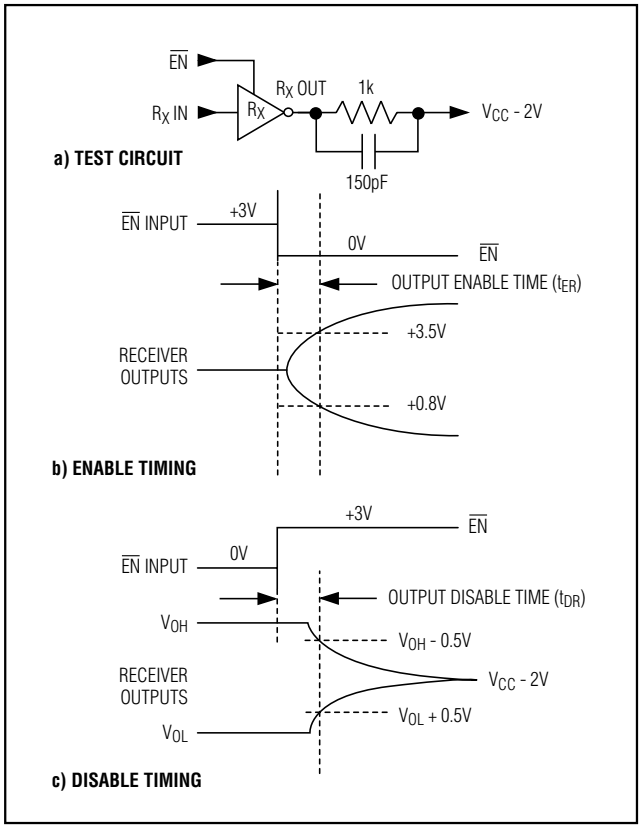


Figure 3. Receiver-Output Enable and Disable Timing

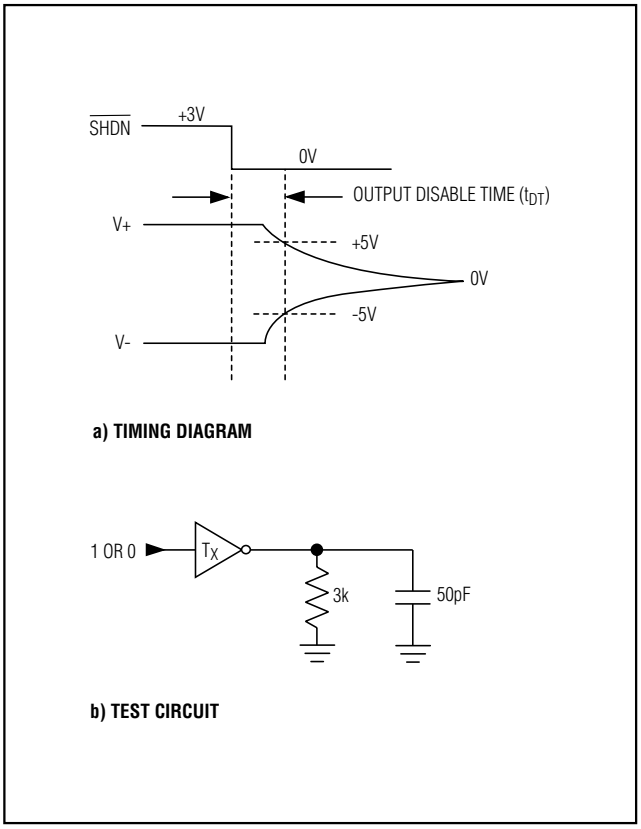


Figure 4. Transmitter-Output Disable Timing

+5V-Powered, Multichannel RS-232 Drivers/Receivers

Table 1a. MAX245 Control Pin Configurations

$\overline{ENT}$	$\overline{ENR}$	OPERATION STATUS	TRANSMITTERS	RECEIVERS
0	0	Normal Operation	All Active	All Active
0	1	Normal Operation	All Active	All 3-State
1	0	Shutdown	All 3-State	All Low-Power Receive Mode
1	1	Shutdown	All 3-State	All 3-State

Table 1b. MAX245 Control Pin Configurations

$\overline{ENT}$	$\overline{ENR}$	OPERATION STATUS	TRANSMITTERS		RECEIVERS	
			TA1–TA4	TB1–TB4	RA1–RA5	RB1–RB5
0	0	Normal Operation	All Active	All Active	All Active	All Active
0	1	Normal Operation	All Active	All Active	RA1–RA4 3-State, RA5 Active	RB1–RB4 3-State, RB5 Active
1	0	Shutdown	All 3-State	All 3-State	All Low-Power Receive Mode	All Low-Power Receive Mode
1	1	Shutdown	All 3-State	All 3-State	RA1–RA4 3-State, RA5 Low-Power Receive Mode	RB1–RB4 3-State, RB5 Low-Power Receive Mode

Table 1c. MAX246 Control Pin Configurations

$\overline{ENA}$	$\overline{ENB}$	OPERATION STATUS	TRANSMITTERS		RECEIVERS	
			TA1–TA4	TB1–TB4	RA1–RA5	RB1–RB5
0	0	Normal Operation	All Active	All Active	All Active	All Active
0	1	Normal Operation	All Active	All 3-State	All Active	RB1–RB4 3-State, RB5 Active
1	0	Shutdown	All 3-State	All Active	RA1–RA4 3-State, RA5 Active	All Active
1	1	Shutdown	All 3-State	All 3-State	RA1–RA4 3-State, RA5 Low-Power Receive Mode	RB1–RB4 3-State, RA5 Low-Power Receive Mode

Table 1d. MAX247/MAX248/MAX249 Control Pin Configurations

$\overline{ENTA}$	$\overline{ENTB}$	$\overline{ENRA}$	$\overline{ENRB}$	OPERATION STATUS		TRANSMITTERS		RECEIVERS	
					MAX247	TA1–TA4	TB1–TB4	RA1–RA4	RB1–RB5
					MAX248	TA1–TA4	TB1–TB4	RA1–RA4	RB1–RB4
					MAX249	TA1–TA3	TB1–TB3	RA1–RA5	RB1–RB5
0	0	0	0	Normal Operation		All Active	All Active	All Active	All Active
0	0	0	1	Normal Operation		All Active	All Active	All Active	All 3-State, except RB5 stays active on MAX247
0	0	1	0	Normal Operation		All Active	All Active	All 3-State	All Active
0	0	1	1	Normal Operation		All Active	All Active	All 3-State	All 3-State, except RB5 stays active on MAX247
0	1	0	0	Normal Operation		All Active	All 3-State	All Active	All Active
0	1	0	1	Normal Operation		All Active	All 3-State	All Active	All 3-State, except RB5 stays active on MAX247
0	1	1	0	Normal Operation		All Active	All 3-State	All 3-State	All Active
0	1	1	1	Normal Operation		All Active	All 3-State	All 3-State	All 3-State, except RB5 stays active on MAX247
1	0	0	0	Normal Operation		All 3-State	All Active	All Active	All Active
1	0	0	1	Normal Operation		All 3-State	All Active	All Active	All 3-State, except RB5 stays active on MAX247
1	0	1	0	Normal Operation		All 3-State	All Active	All 3-State	All Active
1	0	1	1	Normal Operation		All 3-State	All Active	All 3-State	All 3-State, except RB5 stays active on MAX247
1	1	0	0	Shutdown		All 3-State	All 3-State	Low-Power Receive Mode	Low-Power Receive Mode
1	1	0	1	Shutdown		All 3-State	All 3-State	Low-Power Receive Mode	All 3-State, except RB5 stays active on MAX247
1	1	1	0	Shutdown		All 3-State	All 3-State	All 3-State	Low-Power Receive Mode
1	1	1	1	Shutdown		All 3-State	All 3-State	All 3-State	All 3-State, except RB5 stays active on MAX247

+5V-Powered, Multichannel RS-232 Drivers/Receivers

Detailed Description

The MAX220–MAX249 contain four sections: dual charge-pump DC-DC voltage converters, RS-232 drivers, RS-232 receivers, and receiver and transmitter enable control inputs.

Dual Charge-Pump Voltage Converter

The MAX220–MAX249 have two internal charge-pumps that convert +5V to ±10V (unloaded) for RS-232 driver operation. The first converter uses capacitor C1 to double the +5V input to +10V on C3 at the V+ output. The second converter uses capacitor C2 to invert +10V to -10V on C4 at the V- output.

A small amount of power may be drawn from the +10V (V+) and -10V (V-) outputs to power external circuitry (see the *Typical Operating Characteristics* section), except on the MAX225 and MAX245–MAX247, where these pins are not available. V+ and V- are not regulated, so the output voltage drops with increasing load current. Do not load V+ and V- to a point that violates the minimum ±5V EIA/TIA-232E driver output voltage when sourcing current from V+ and V- to external circuitry.

When using the shutdown feature in the MAX222, MAX225, MAX230, MAX235, MAX236, MAX240, MAX241, and MAX245–MAX249, avoid using V+ and V- to power external circuitry. When these parts are shut down, V- falls to 0V, and V+ falls to +5V. For applications where a +10V external supply is applied to the V+ pin (instead of using the internal charge pump to generate +10V), the C1 capacitor must not be installed and the $\overline{SHDN}$ pin must be tied to V_{CC}. This is because V+ is internally connected to V_{CC} in shutdown mode.

RS-232 Drivers

The typical driver output voltage swing is ±8V when loaded with a nominal 5kΩ RS-232 receiver and V_{CC} = +5V. Output swing is guaranteed to meet the EIA/TIA-232E and V.28 specification, which calls for ±5V minimum driver output levels under worst-case conditions. These include a minimum 3kΩ load, V_{CC} = +4.5V, and maximum operating temperature. Unloaded driver output voltage ranges from (V+ -1.3V) to (V- +0.5V).

Input thresholds are both TTL and CMOS compatible. The inputs of unused drivers can be left unconnected since 400kΩ input pull-up resistors to V_{CC} are built in (except for the MAX220). The pull-up resistors force the outputs of unused drivers low because all drivers invert. The internal input pull-up resistors typically source 12µA, except in shutdown mode where the pull-ups are disabled. Driver outputs turn off and enter a high-impedance state—where leakage current is typically microamperes (maximum 25µA)—when in shutdown mode, in three-state mode, or when device power is removed. Outputs can be driven to ±15V. The power-supply current typically drops to 8µA in shutdown mode. The MAX220 does not have pull-up resistors to force the ouputs of the unused drivers low. Connect unused inputs to GND or V_{CC}.

The MAX239 has a receiver three-state control line, and the MAX223, MAX225, MAX235, MAX236, MAX240, and MAX241 have both a receiver three-state control line and a low-power shutdown control. Table 2 shows the effects of the shutdown control and receiver three-state control on the receiver outputs.

The receiver TTL/CMOS outputs are in a high-impedance, three-state mode whenever the three-state enable line is high (for the MAX225/MAX235/MAX236/MAX239–MAX241), and are also high-impedance whenever the shutdown control line is high.

When in low-power shutdown mode, the driver outputs are turned off and their leakage current is less than 1µA with the driver output pulled to ground. The driver output leakage remains less than 1µA, even if the transmitter output is backdriven between 0V and (V_{CC} + 6V). Below -0.5V, the transmitter is diode clamped to ground with 1kΩ series impedance. The transmitter is also zener clamped to approximately V_{CC} + 6V, with a series impedance of 1kΩ.

The driver output slew rate is limited to less than 30V/µs as required by the EIA/TIA-232E and V.28 specifications. Typical slew rates are 24V/µs unloaded and 10V/µs loaded with 3Ω and 2500pF.

RS-232 Receivers

EIA/TIA-232E and V.28 specifications define a voltage level greater than 3V as a logic 0, so all receivers invert. Input thresholds are set at 0.8V and 2.4V, so receivers respond to TTL level inputs as well as EIA/TIA-232E and V.28 levels.

The receiver inputs withstand an input overvoltage up to ±25V and provide input terminating resistors with

Table 2. Three-State Control of Receivers

PART	SHDN	$\overline{SHDN}$	EN	$\overline{EN(R)}$	RECEIVERS
MAX223	—	Low High High	X Low High	—	High Impedance Active High Impedance
MAX225	—	—	—	Low High	High Impedance Active
MAX235 MAX236 MAX240	Low Low High	—	—	Low High X	High Impedance Active High Impedance

nominal 5kΩ values. The receivers implement Type 1 interpretation of the fault conditions of V.28 and EIA/TIA-232E.

The receiver input hysteresis is typically 0.5V with a guaranteed minimum of 0.2V. This produces clear output transitions with slow-moving input signals, even with moderate amounts of noise and ringing. The receiver propagation delay is typically 600ns and is independent of input swing direction.

Low-Power Receive Mode

The low-power receive-mode feature of the MAX223, MAX242, and MAX245–MAX249 puts the IC into shutdown mode but still allows it to receive information. This is important for applications where systems are periodically awakened to look for activity. Using low-power receive mode, the system can still receive a signal that will activate it on command and prepare it for communication at faster data rates. This operation conserves system power.

Negative Threshold—MAX243

The MAX243 is pin compatible with the MAX232A, differing only in that RS-232 cable fault protection is removed on one of the two receiver inputs. This means that control lines such as CTS and RTS can either be driven or left floating without interrupting communication. Different cables are not needed to interface with different pieces of equipment.

The input threshold of the receiver without cable fault protection is -0.8V rather than +1.4V. Its output goes positive only if the input is connected to a control line that is actively driven negative. If not driven, it defaults to the 0 or "OK to send" state. Normally, the MAX243's other receiver (+1.4V threshold) is used for the data line (TD or RD), while the negative threshold receiver is connected to the control line (DTR, DTS, CTS, RTS, etc.).

Other members of the RS-232 family implement the optional cable fault protection as specified by EIA/TIA-232E specifications. This means a receiver output goes high whenever its input is driven negative, left floating, or shorted to ground. The high output tells the serial communications IC to stop sending data. To avoid this, the control lines must either be driven or connected with jumpers to an appropriate positive voltage level.

Shutdown—MAX222–MAX242

On the MAX222, MAX235, MAX236, MAX240, and MAX241, all receivers are disabled during shutdown. On the MAX223 and MAX242, two receivers continue to operate in a reduced power mode when the chip is in shutdown. Under these conditions, the propagation delay increases to about 2.5µs for a high-to-low input transition. When in shutdown, the receiver acts as a CMOS inverter with no hysteresis. The MAX223 and MAX242 also have a receiver output enable input ($\overline{EN}$ for the MAX242 and EN for the MAX223) that allows receiver output control independent of $\overline{SHDN}$ (SHDN for MAX241). With all other devices, $\overline{SHDN}$ (SHDN for MAX241) also disables the receiver outputs.

The MAX225 provides five transmitters and five receivers, while the MAX245 provides ten receivers and eight transmitters. Both devices have separate receiver and transmitter-enable controls. The charge pumps turn off and the devices shut down when a logic high is applied to the ENT input. In this state, the supply current drops to less than 25µA and the receivers continue to operate in a low-power receive mode. Driver outputs enter a high-impedance state (three-state mode). On the MAX225, all five receivers are controlled by the $\overline{ENR}$ input. On the MAX245, eight of the receiver outputs are controlled by the $\overline{ENR}$ input, while the remaining two receivers (RA5 and RB5) are always active. RA1–RA4 and RB1–RB4 are put in a three-state mode when $\overline{ENR}$ is a logic high.

Receiver and Transmitter Enable Control Inputs

The MAX225 and MAX245–MAX249 feature transmitter and receiver enable controls.

The receivers have three modes of operation: full-speed receive (normal active), three-state (disabled), and low-power receive (enabled receivers continue to function at lower data rates). The receiver enable inputs control the full-speed receive and three-state modes. The transmitters have two modes of operation: full-speed transmit (normal active) and three-state (disabled). The transmitter enable inputs also control the shutdown mode. The device enters shutdown mode when all transmitters are disabled. Enabled receivers function in the low-power receive mode when in shutdown.

+5V-Powered, Multichannel RS-232 Drivers/Receivers

Tables 1a–1d define the control states. The MAX244 has no control pins and is not included in these tables.

The MAX246 has ten receivers and eight drivers with two control pins, each controlling one side of the device. A logic high at the A-side control input ($\overline{ENA}$) causes the four A-side receivers and drivers to go into a three-state mode. Similarly, the B-side control input ($\overline{ENB}$) causes the four B-side drivers and receivers to go into a three-state mode. As in the MAX245, one A-side and one B-side receiver (RA5 and RB5) remain active at all times. The entire device is put into shutdown mode when both the A and B sides are disabled ($\overline{ENA}$ = $\overline{ENB}$ = +5V).

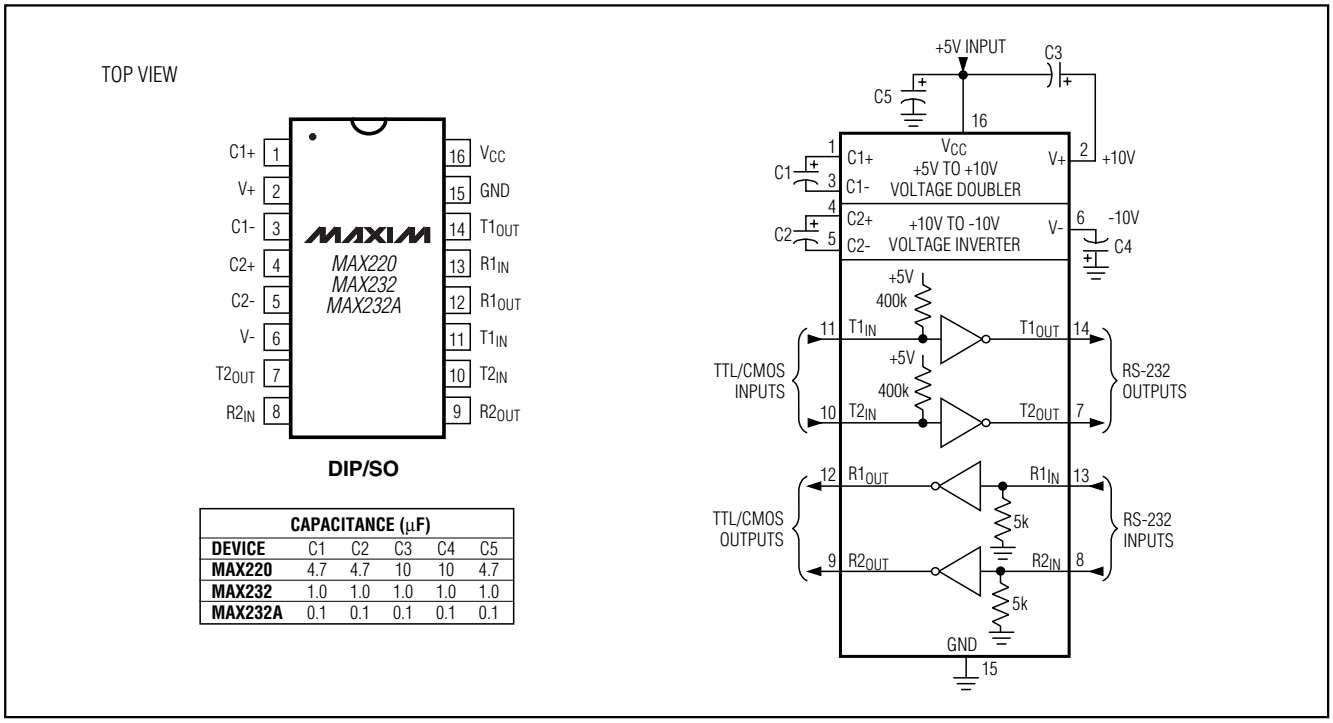
The MAX247 provides nine receivers and eight drivers with four control pins. The $\overline{ENRA}$ and $\overline{ENRB}$ receiver enable inputs each control four receiver outputs. The $\overline{ENTA}$ and $\overline{ENTB}$ transmitter enable inputs each control four drivers. The ninth receiver (RB5) is always active. The device enters shutdown mode with a logic high on both $\overline{ENTA}$ and $\overline{ENTB}$.

The MAX248 provides eight receivers and eight drivers with four control pins. The $\overline{ENRA}$ and $\overline{ENRB}$ receiver enable inputs each control four receiver outputs. The $\overline{ENTA}$ and $\overline{ENTB}$ transmitter enable inputs control four drivers each. This part does not have an always-active receiver. The device enters shutdown mode and transmitters go into a three-state mode with a logic high on both $\overline{ENTA}$ and $\overline{ENTB}$.

The MAX249 provides ten receivers and six drivers with four control pins. The $\overline{ENRA}$ and $\overline{ENRB}$ receiver enable inputs each control five receiver outputs. The $\overline{ENTA}$ and $\overline{ENTB}$ transmitter enable inputs control three drivers each. There is no always-active receiver. The device enters shutdown mode and transmitters go into a three-state mode with a logic high on both $\overline{ENTA}$ and $\overline{ENTB}$. In shutdown mode, active receivers operate in a low-power receive mode at data rates up to 20kbits/sec.

Applications Information

Figures 5 through 25 show pin configurations and typical operating circuits. In applications that are sensitive to power-supply noise, V_{CC} should be decoupled to ground with a capacitor of the same value as C1 and C2 connected as close as possible to the device.



CAPACITANCE (µF)					
DEVICE	C1	C2	C3	C4	C5
MAX220	4.7	4.7	10	10	4.7
MAX232	1.0	1.0	1.0	1.0	1.0
MAX232A	0.1	0.1	0.1	0.1	0.1

Figure 5. MAX220/MAX232/MAX232A Pin Configuration and Typical Operating Circuit

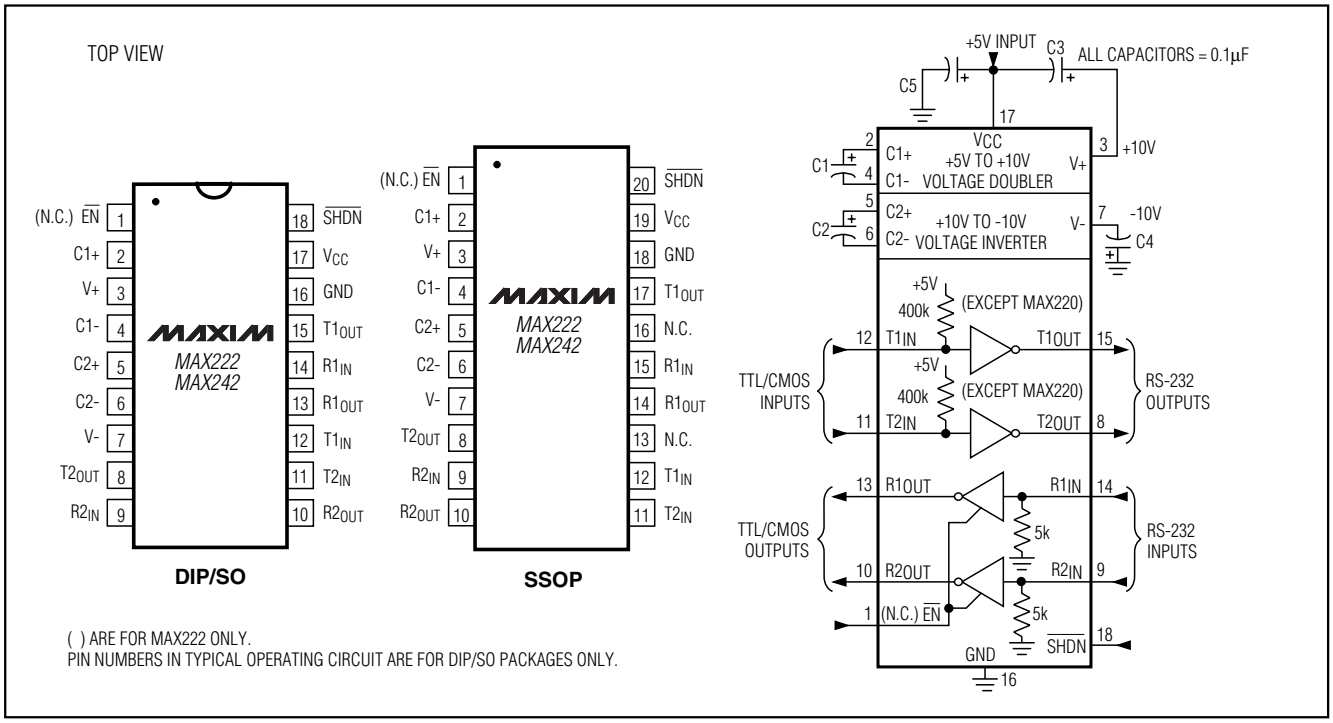
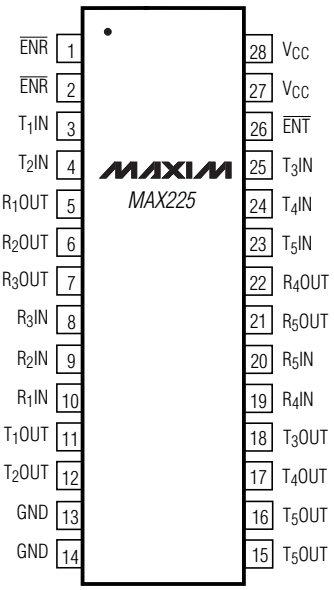


Figure 6. MAX222/MAX242 Pin Configurations and Typical Operating Circuit

+5V-Powered, Multichannel RS-232 Drivers/Receivers

TOP VIEW



SO

MAX225 FUNCTIONAL DESCRIPTION

5 RECEIVERS

5 TRANSMITTERS

2 CONTROL PINS

1 RECEIVER ENABLE ($\overline{ENR}$)

1 TRANSMITTER ENABLE ($\overline{ENT}$)

PINS ($\overline{ENR}$, GND, V_{CC}, T_5OUT) ARE INTERNALLY CONNECTED. CONNECT EITHER OR BOTH EXTERNALLY. T_5OUT IS A SINGLE DRIVER.

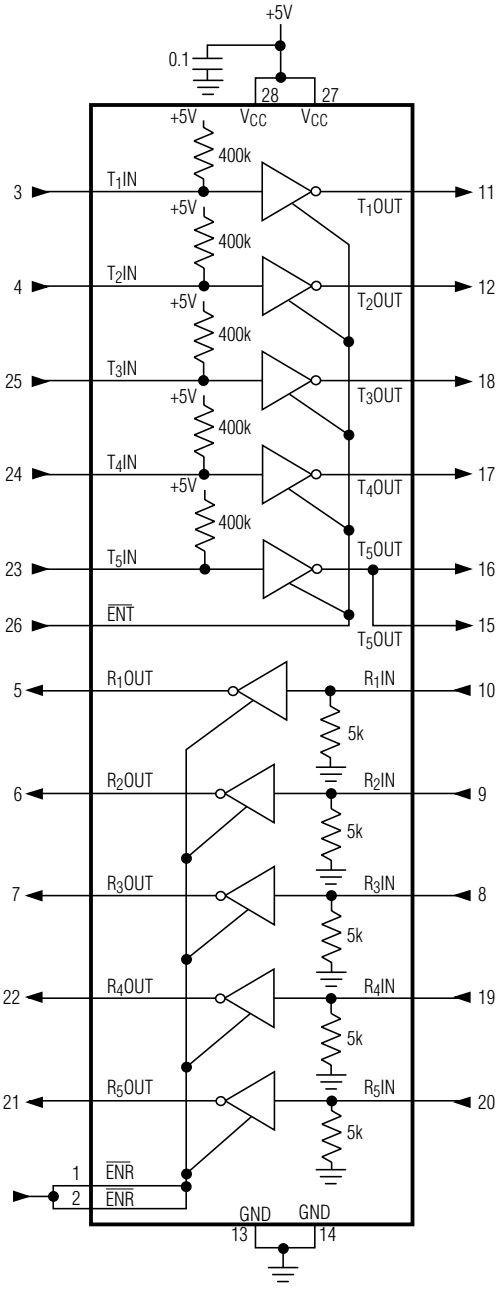


Figure 7. MAX225 Pin Configuration and Typical Operating Circuit

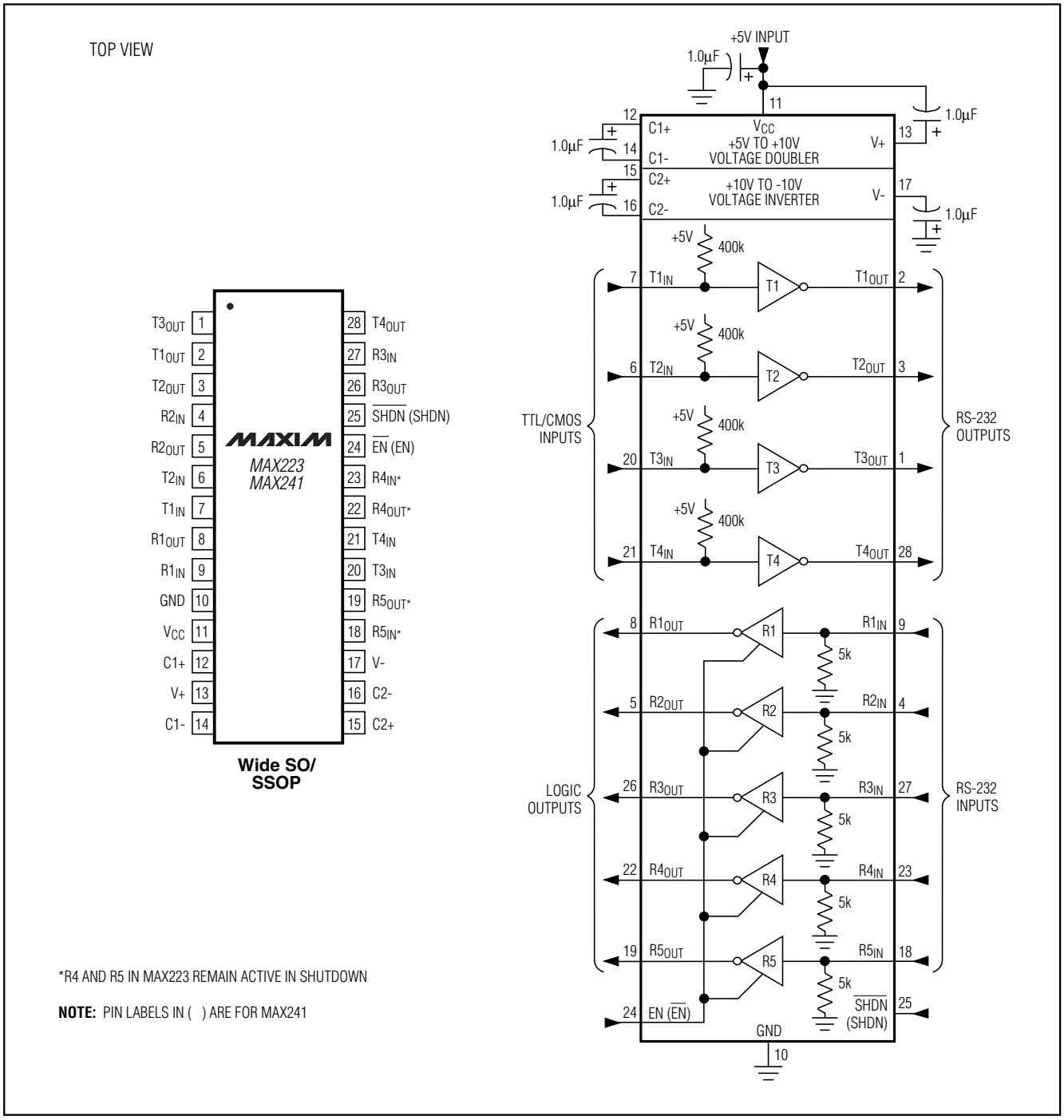


Figure 8. MAX223/MAX241 Pin Configuration and Typical Operating Circuit

+5V-Powered, Multichannel RS-232 Drivers/Receivers

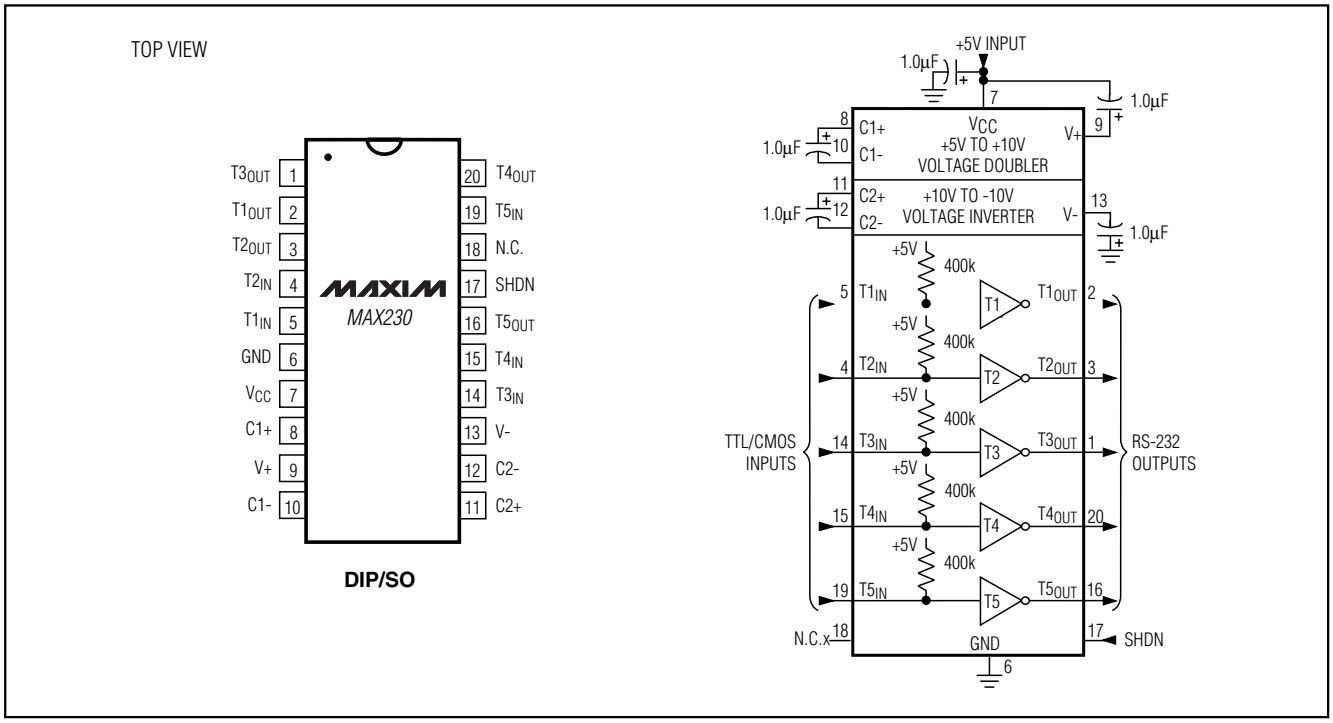


Figure 9. MAX230 Pin Configuration and Typical Operating Circuit

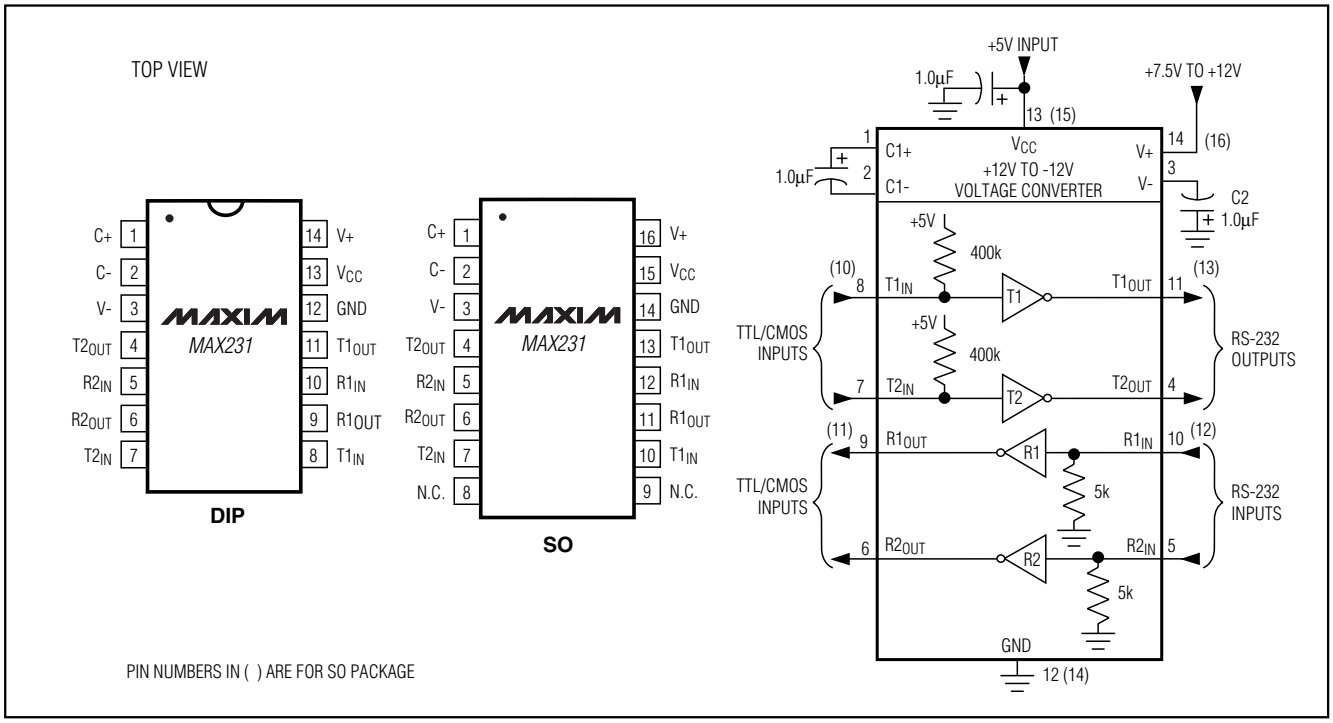


Figure 10. MAX231 Pin Configurations and Typical Operating Circuit

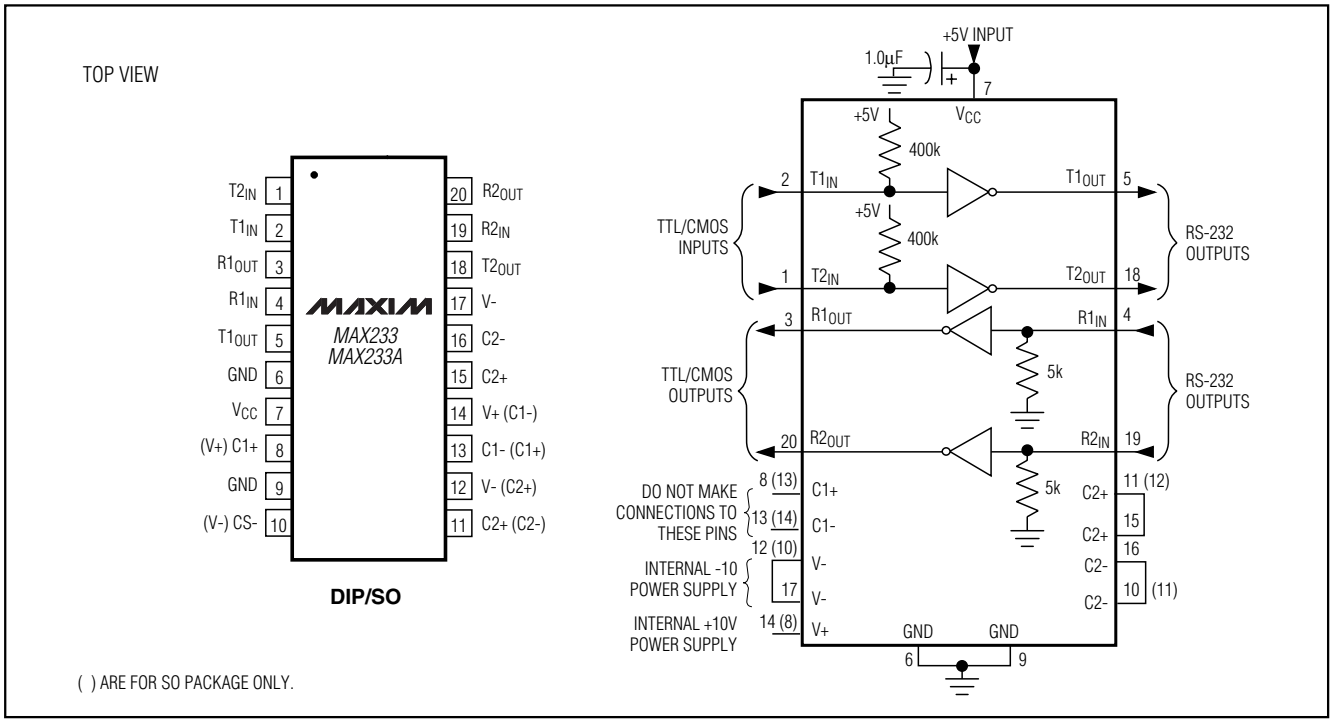


Figure 11. MAX233/MAX233A Pin Configuration and Typical Operating Circuit

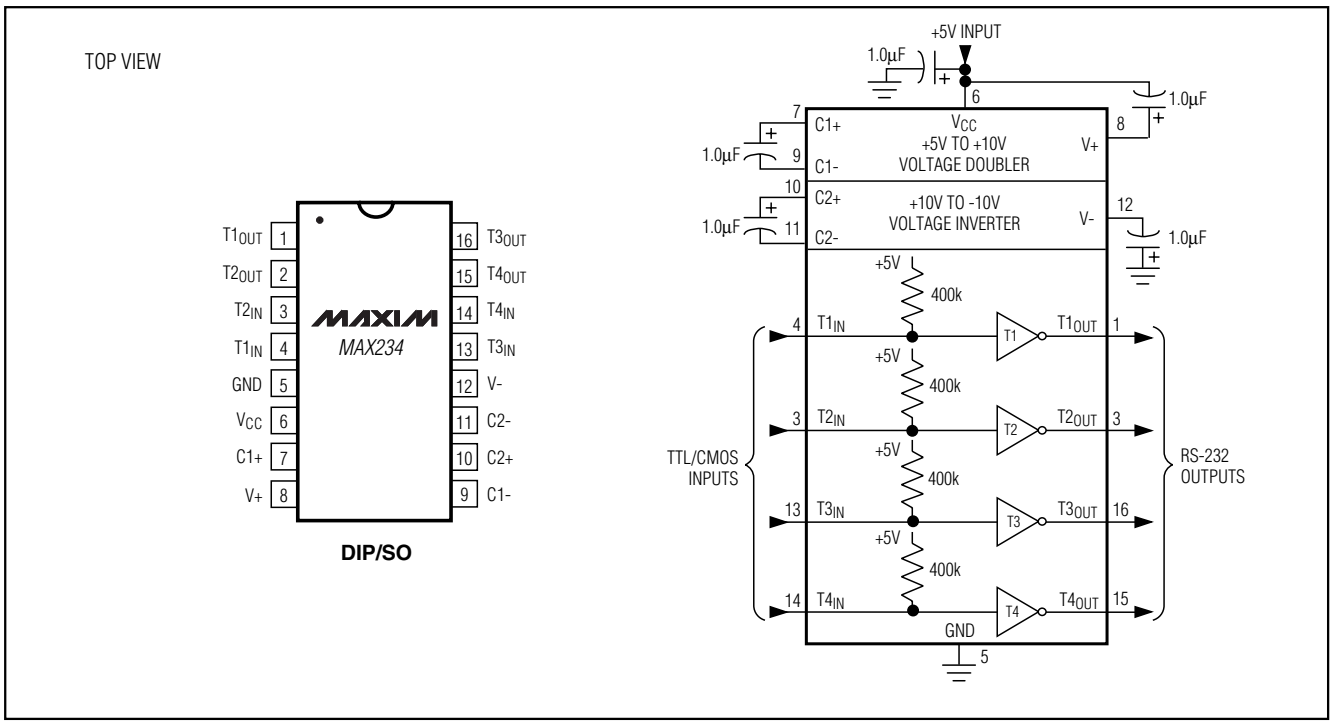


Figure 12. MAX234 Pin Configuration and Typical Operating Circuit

+5V-Powered, Multichannel RS-232 Drivers/Receivers

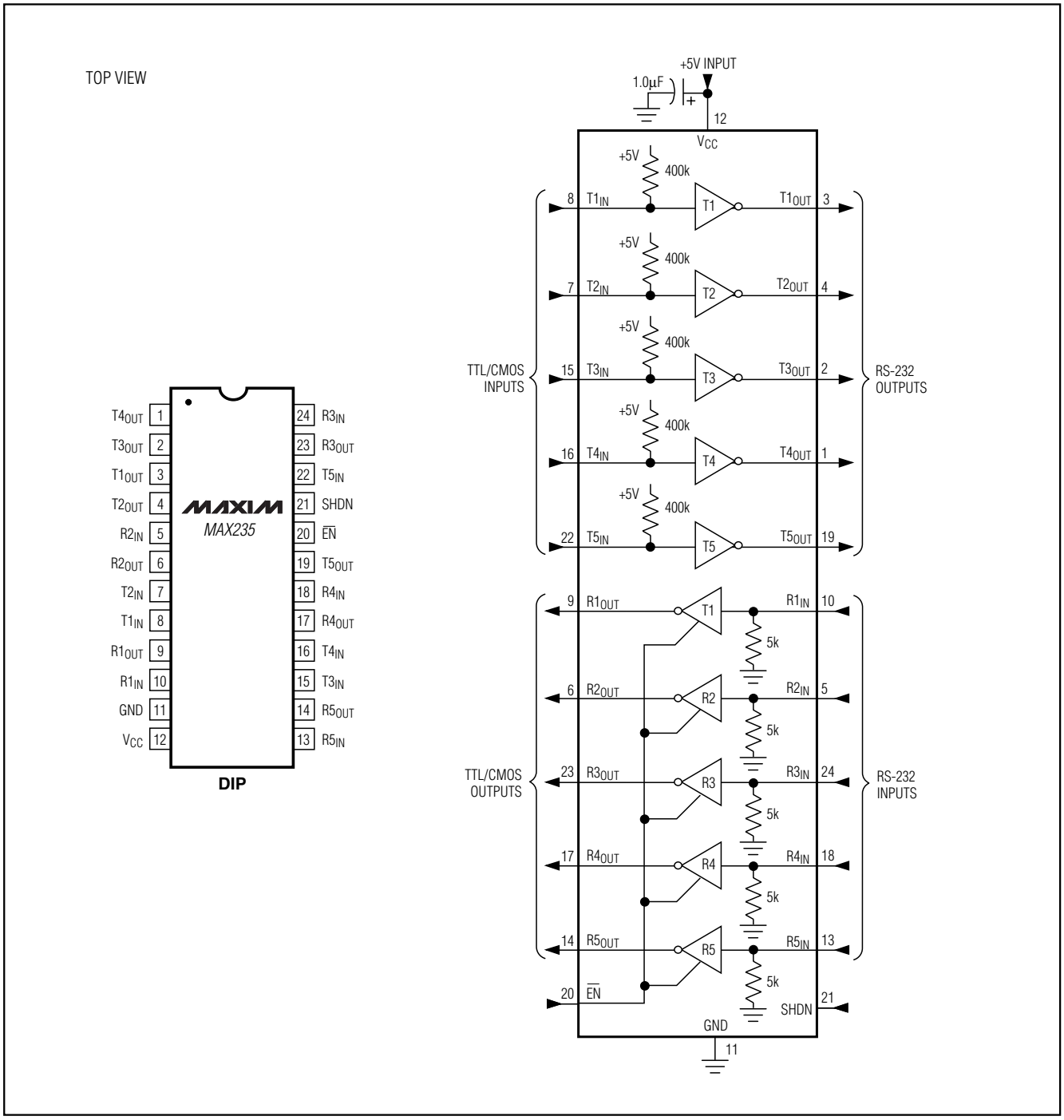
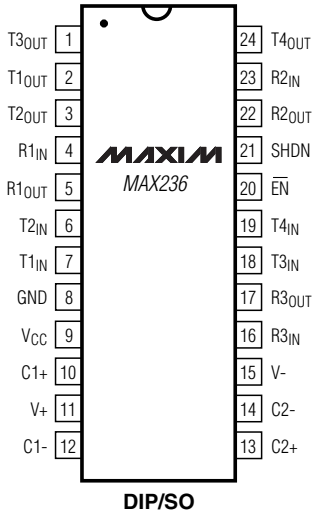


Figure 13. MAX235 Pin Configuration and Typical Operating Circuit



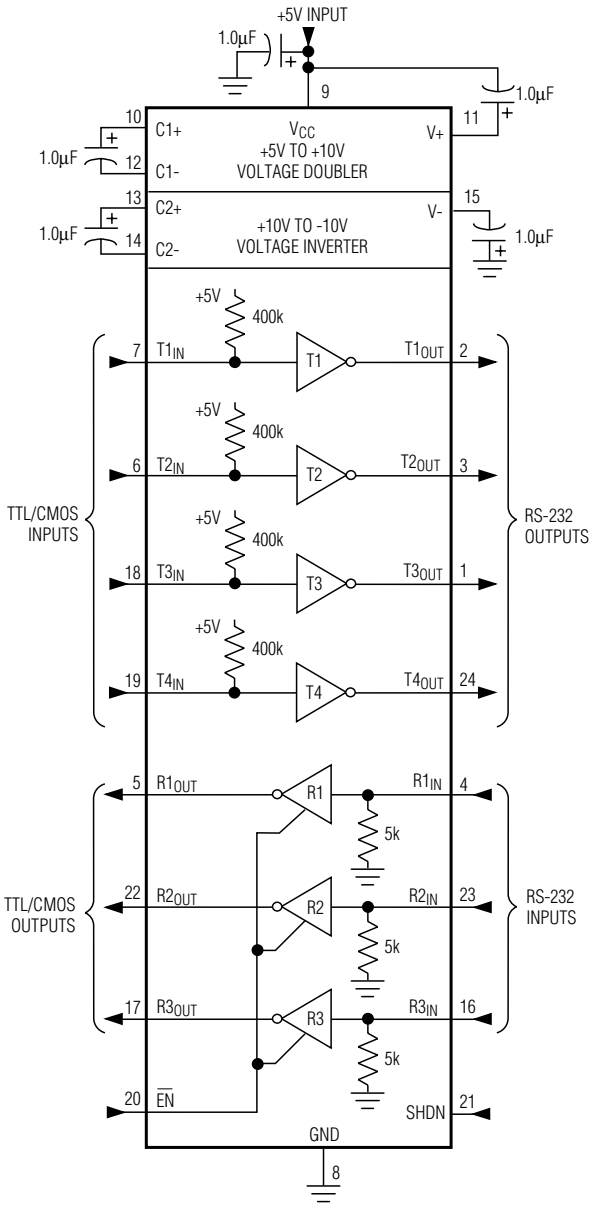


Figure 14. MAX236 Pin Configuration and Typical Operating Circuit

+5V-Powered, Multichannel RS-232 Drivers/Receivers

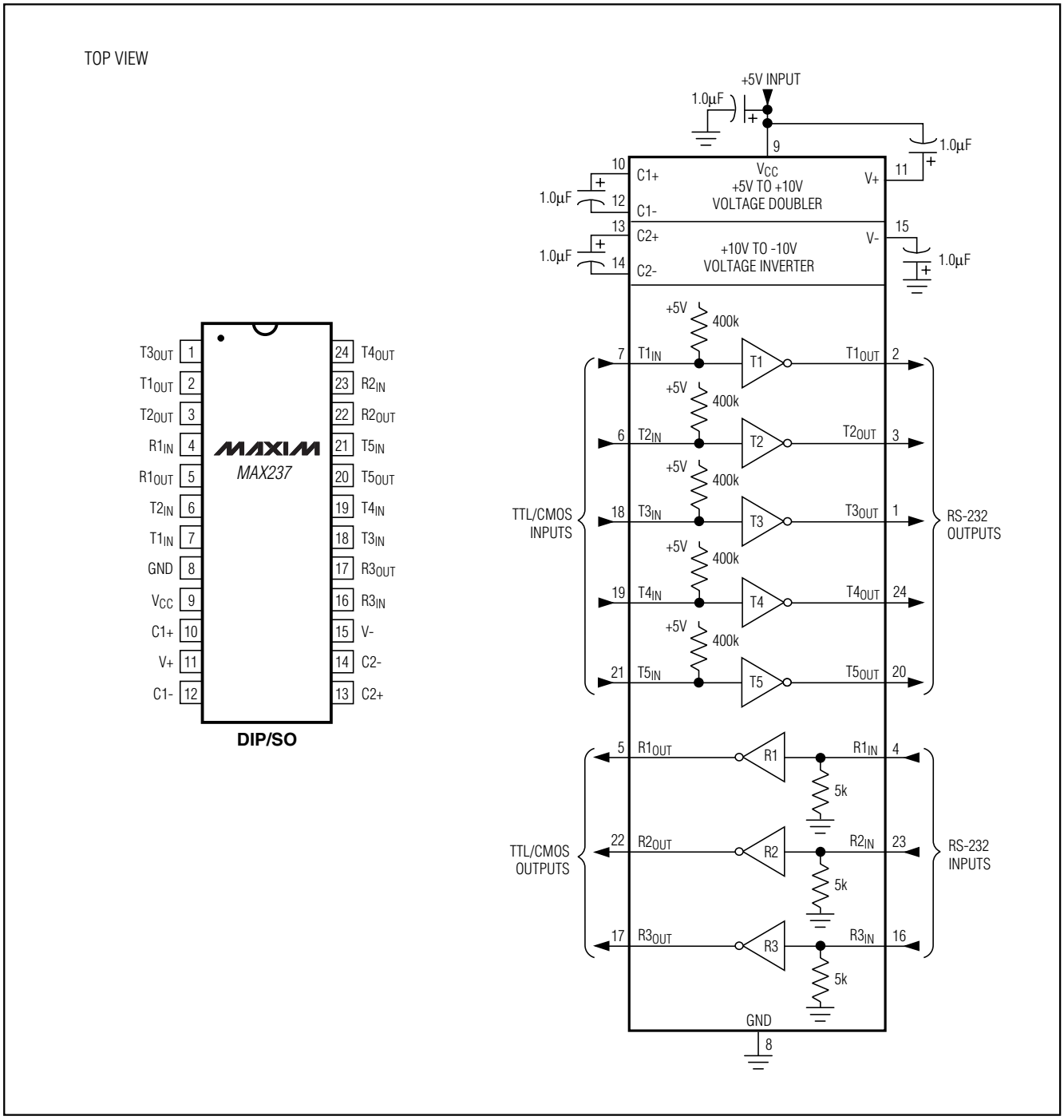


Figure 15. MAX237 Pin Configuration and Typical Operating Circuit

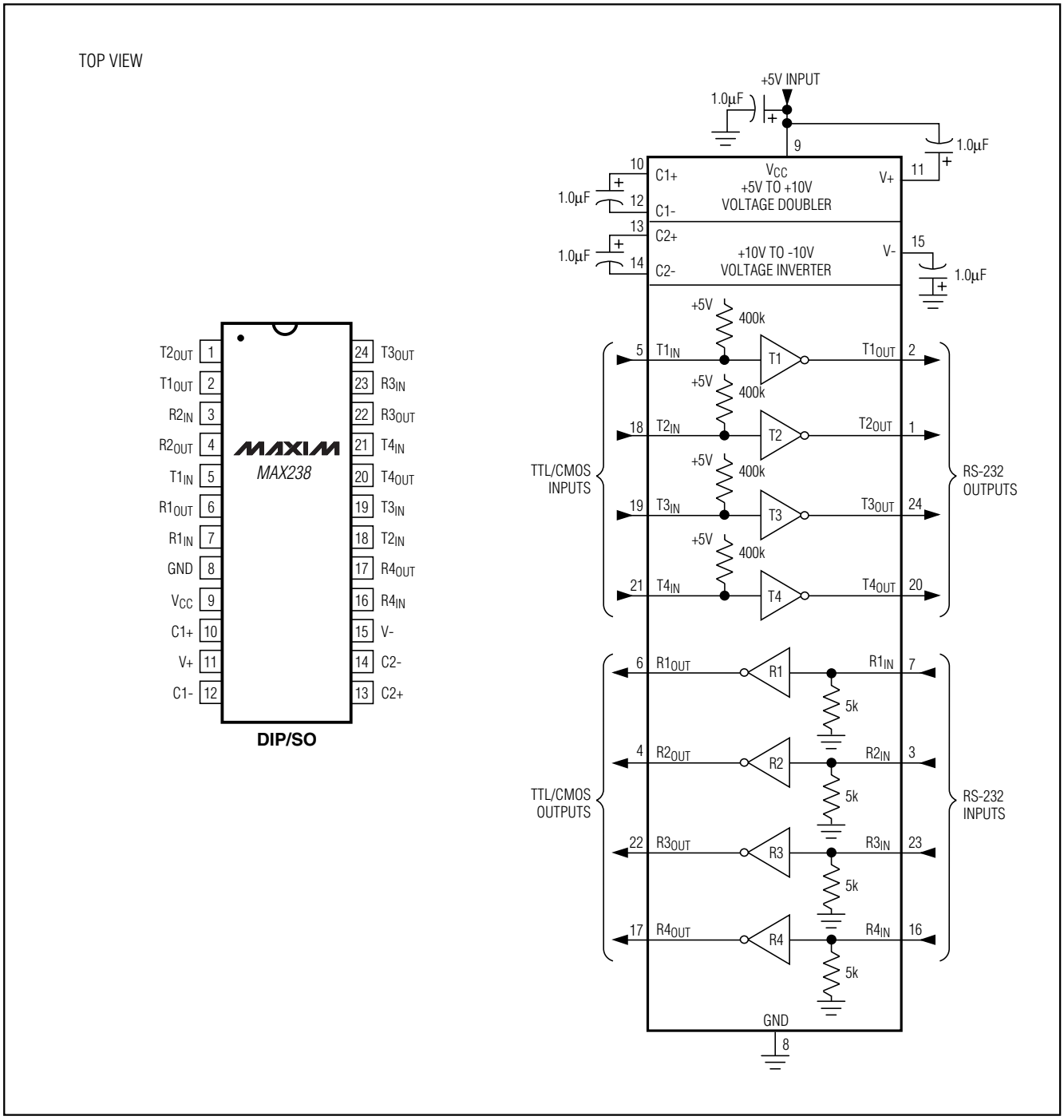


Figure 16. MAX238 Pin Configuration and Typical Operating Circuit

+5V-Powered, Multichannel RS-232 Drivers/Receivers

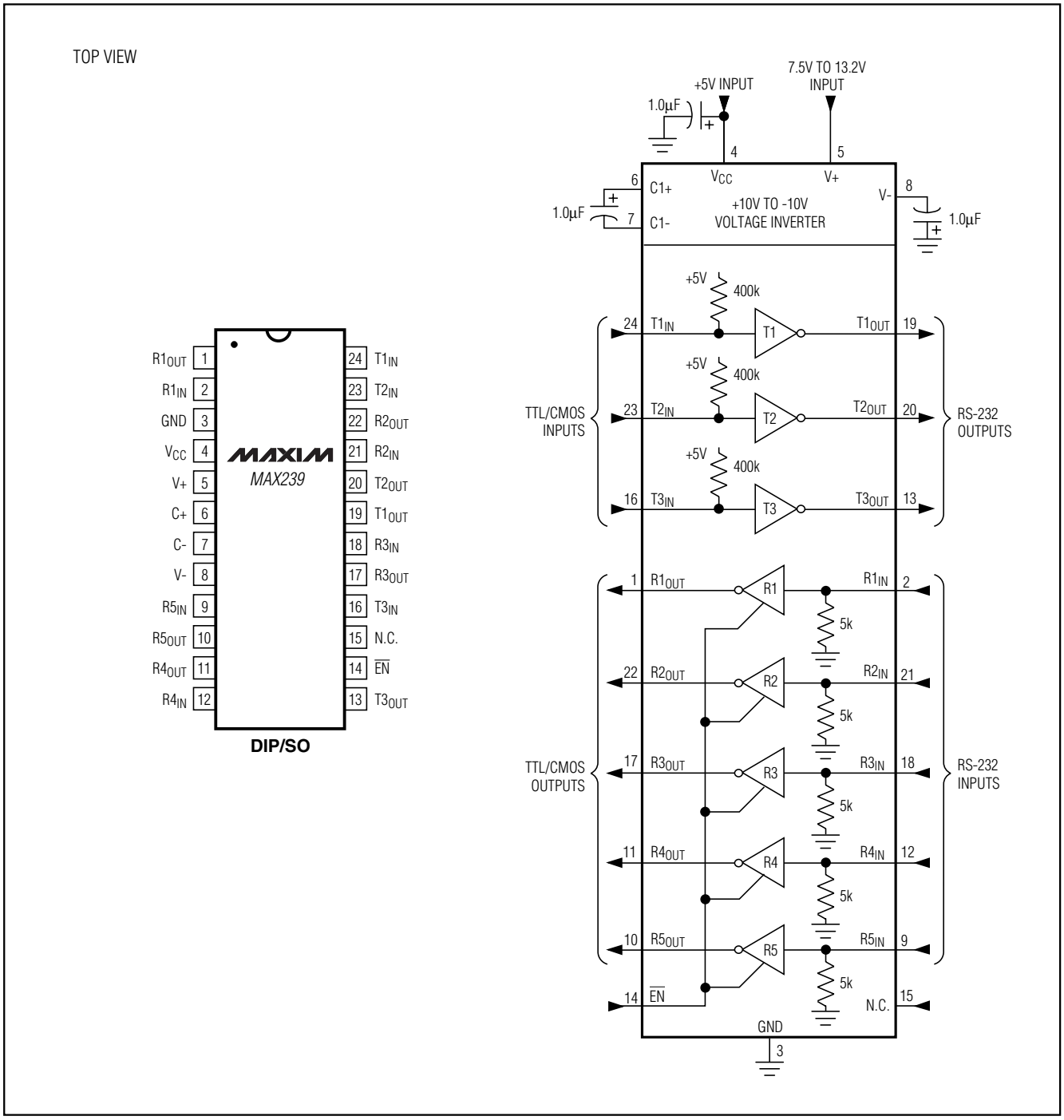


Figure 17. MAX239 Pin Configuration and Typical Operating Circuit

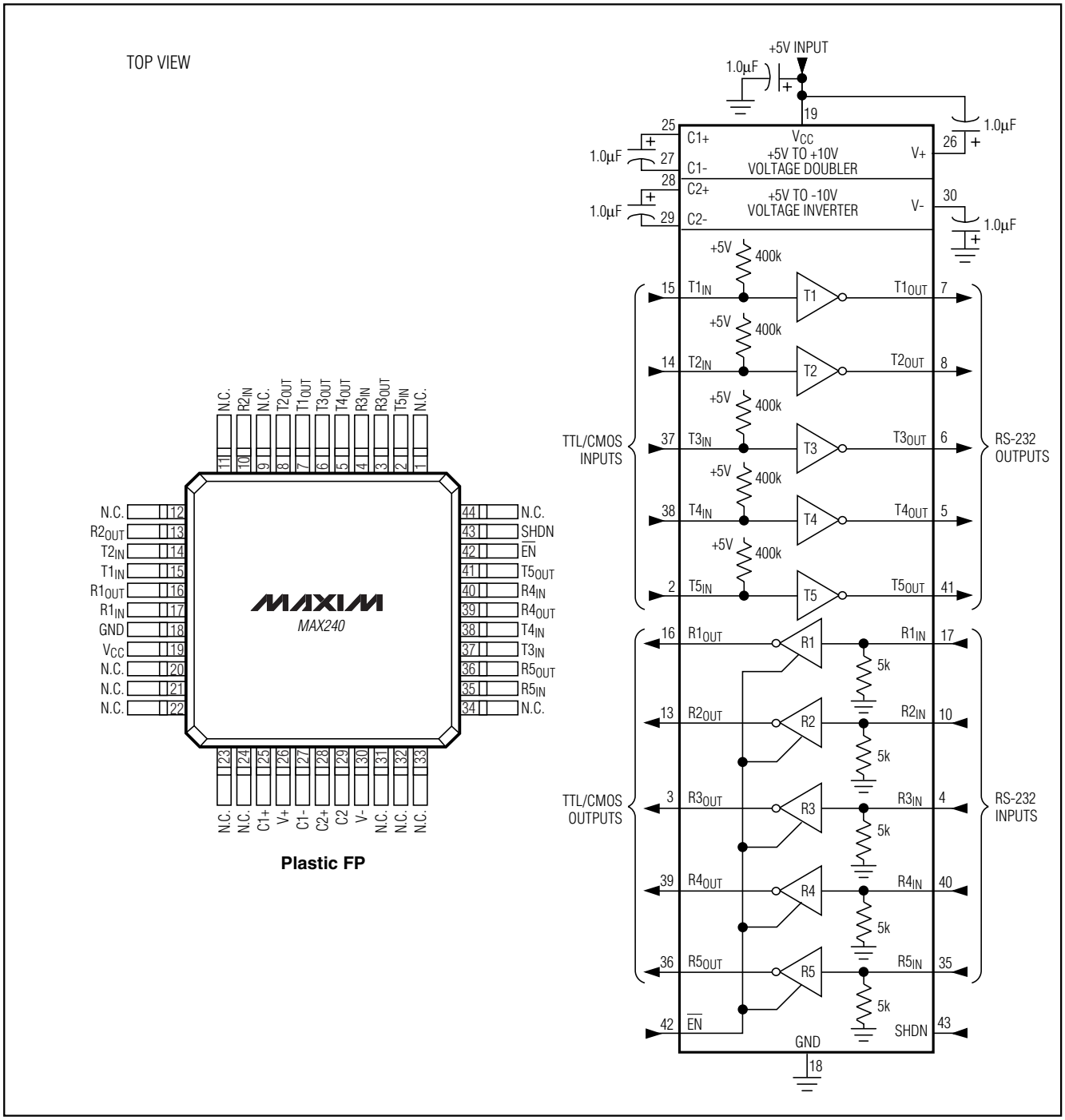
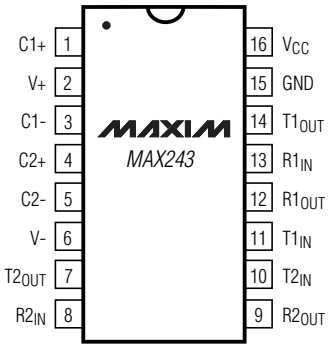


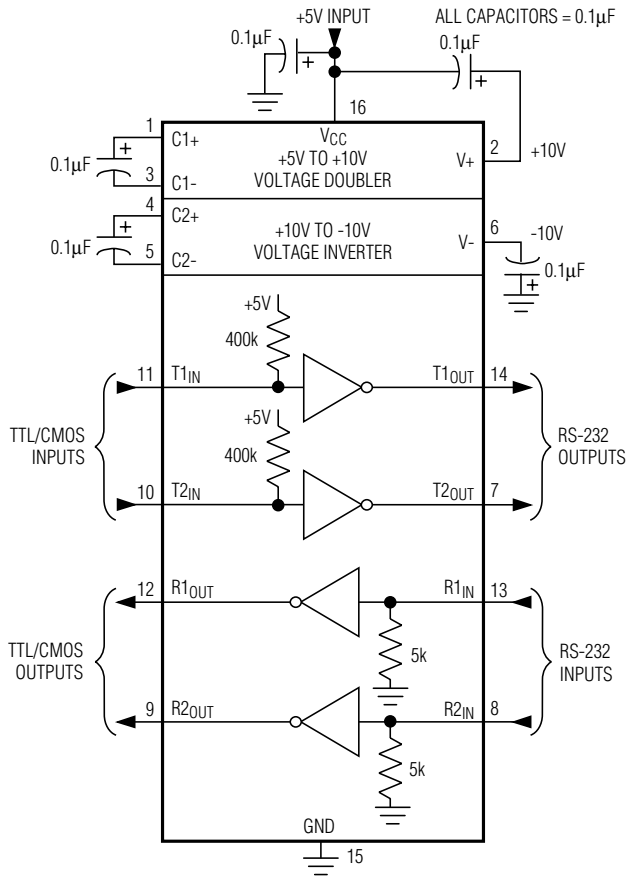
Figure 18. MAX240 Pin Configuration and Typical Operating Circuit

+5V-Powered, Multichannel RS-232 Drivers/Receivers

TOP VIEW

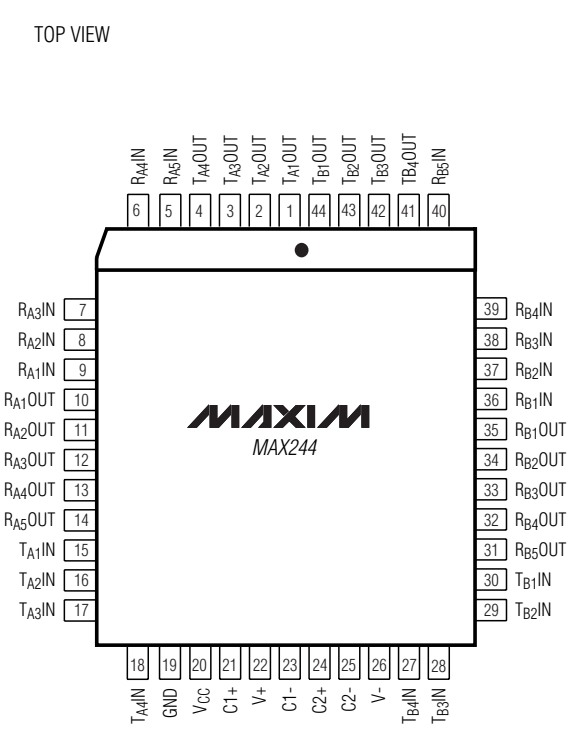


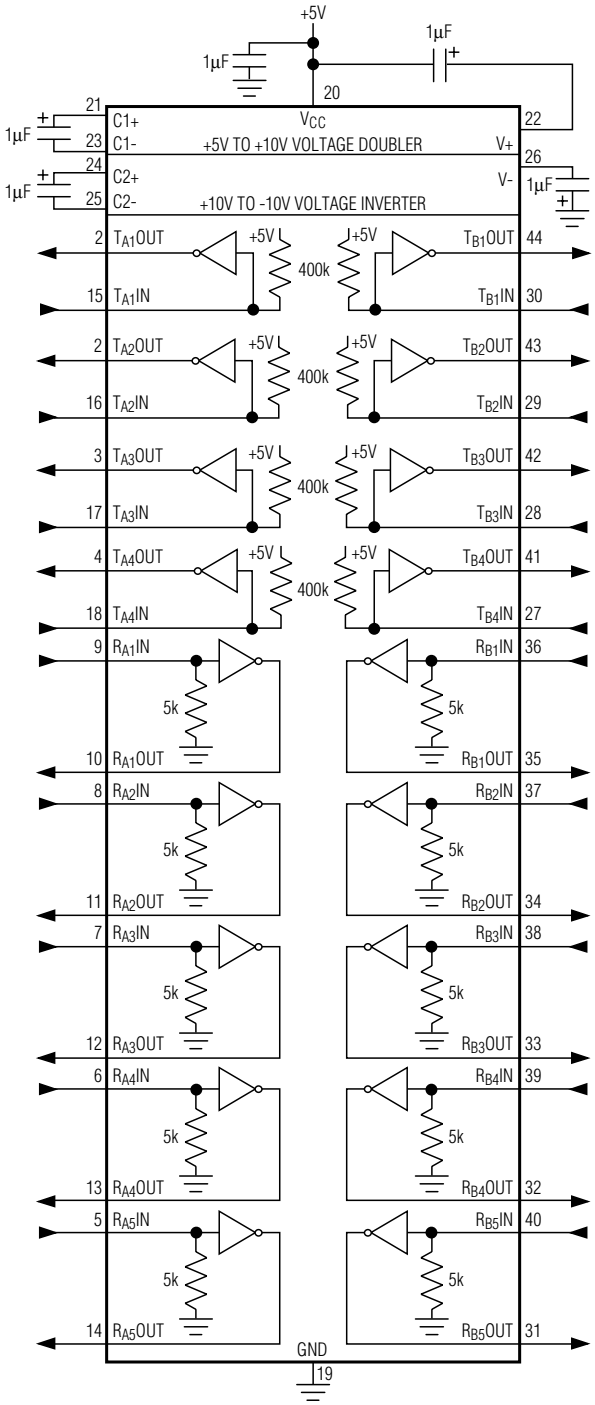
DIP/SO



RECEIVER INPUT	R1 OUTPUT	R2 OUTPUT
≤ -3 V	HIGH	HIGH
OPEN	HIGH	LOW
≥ +3V	LOW	LOW

Figure 19. MAX243 Pin Configuration and Typical Operating Circuit





MAX249 FUNCTIONAL DESCRIPTION

10 RECEIVERS
- 5 A-SIDE RECEIVER
- 5 B-SIDE RECEIVER

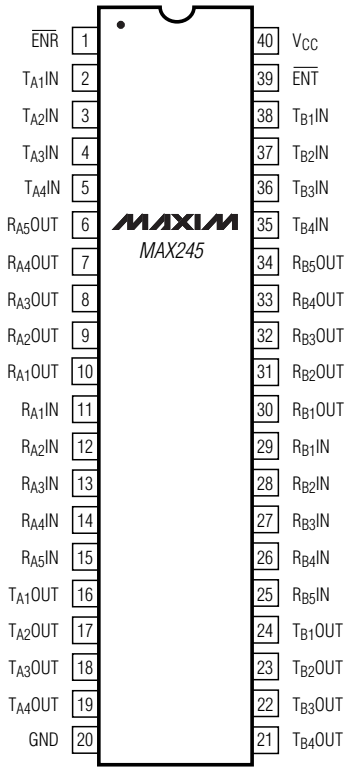
8 TRANSMITTERS
- 4 A-SIDE TRANSMITTERS
- 4 B-SIDE TRANSMITTERS

NO CONTROL PINS

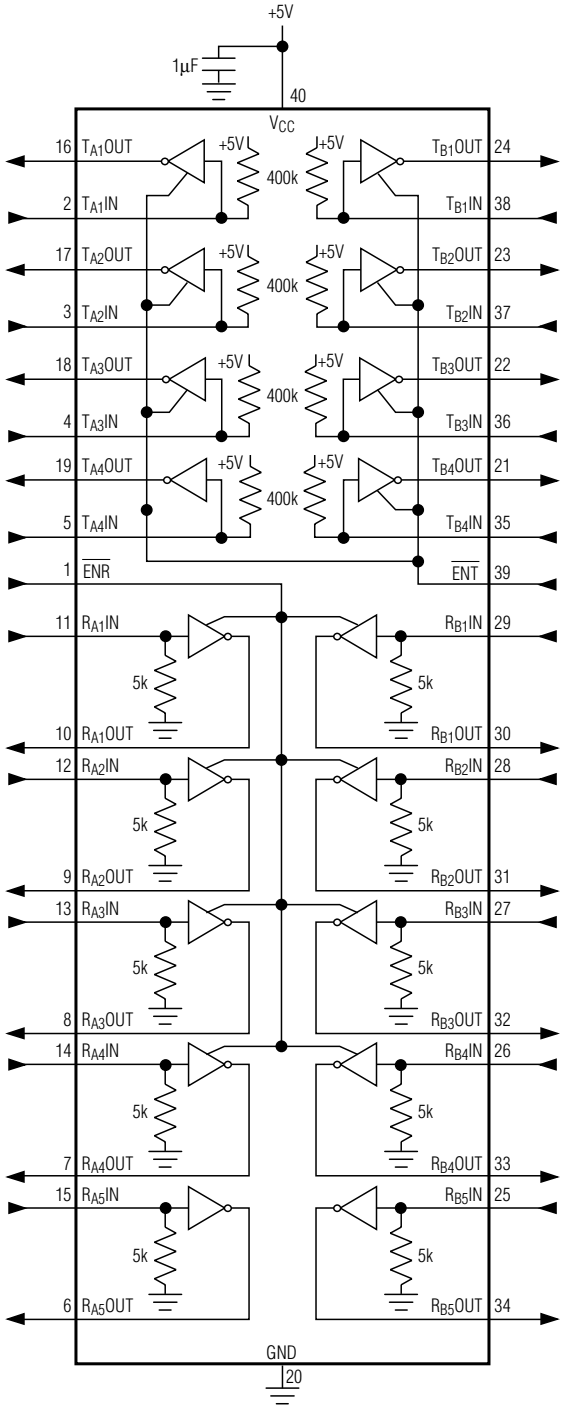
Figure 20. MAX244 Pin Configuration and Typical Operating Circuit

+5V-Powered, Multichannel RS-232 Drivers/Receivers

TOP VIEW



DIP



MAX245 FUNCTIONAL DESCRIPTION

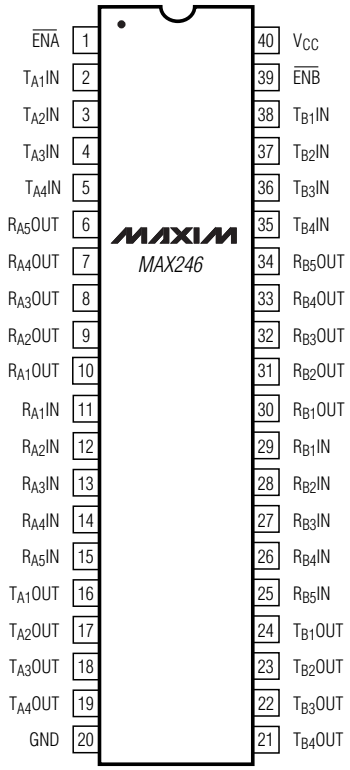
10 RECEIVERS
- 5 A-SIDE RECEIVERS (R_{A5} ALWAYS ACTIVE)
- 5 B-SIDE RECEIVERS (R_{B5} ALWAYS ACTIVE)

8 TRANSMITTTERS
- 4 A-SIDE TRANSMITTERS

2 CONTROL PINS
- 1 RECEIVER ENABLE ($\overline{ENR}$)
- 1 TRANSMITTER ENABLE ($\overline{ENT}$)

Figure 21. MAX245 Pin Configuration and Typical Operating Circuit

TOP VIEW



DIP

MAX246 FUNCTIONAL DESCRIPTION

10 RECEIVERS
- 5 A-SIDE RECEIVERS (R_{A5} ALWAYS ACTIVE)
- 5 B-SIDE RECEIVERS (R_{B5} ALWAYS ACTIVE)

8 TRANSMITTERS
- 4 A-SIDE TRANSMITTERS
- 4 B-SIDE TRANSMITTERS

2 CONTROL PINS
- ENABLE A-SIDE ($\overline{ENA}$)
- ENABLE B-SIDE ($\overline{ENB}$)

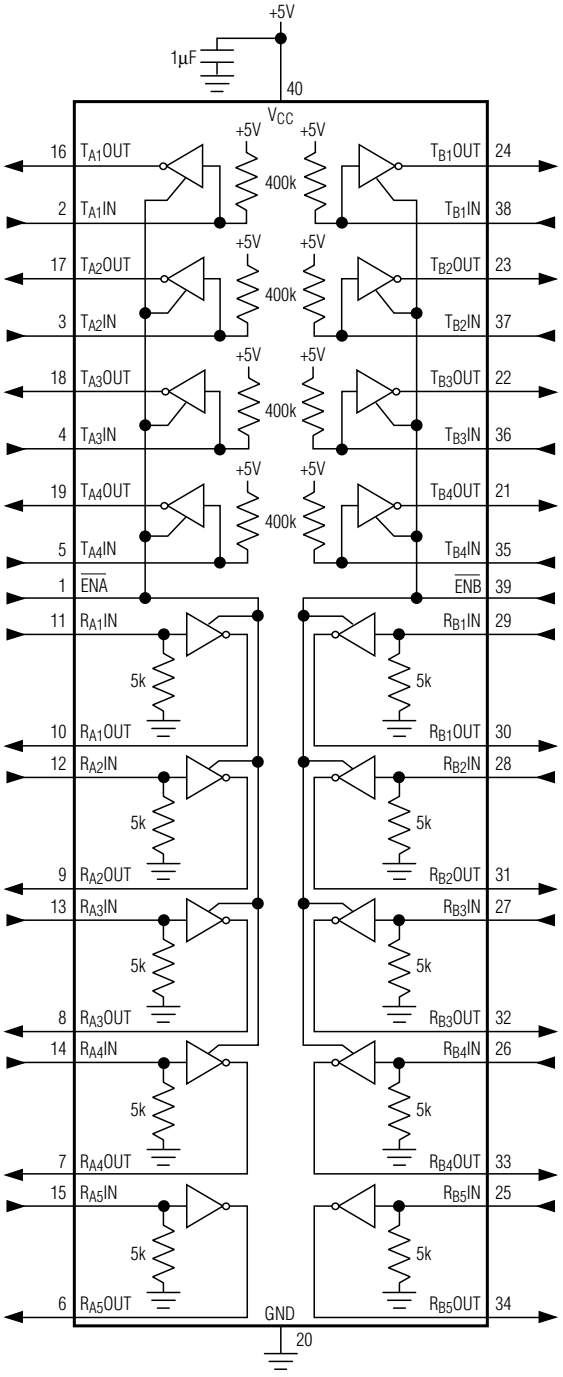
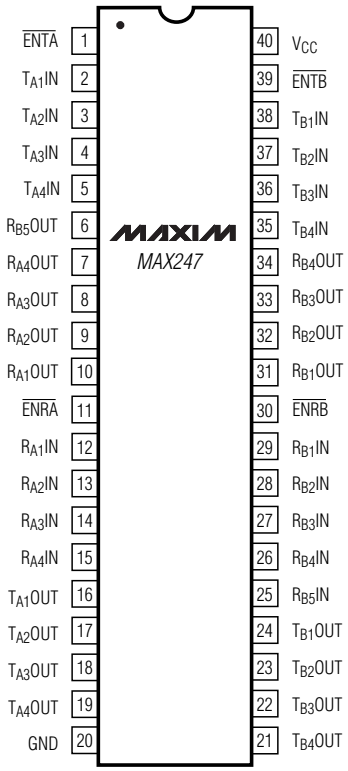


Figure 22. MAX246 Pin Configuration and Typical Operating Circuit

+5V-Powered, Multichannel RS-232 Drivers/Receivers

TOP VIEW



DIP

MAX247 FUNCTIONAL DESCRIPTION

9 RECEIVERS
- 4 A-SIDE RECEIVERS
- 5 B-SIDE RECEIVERS (R_{B5} ALWAYS ACTIVE)

8 TRANSMITTERS
- 4 A-SIDE TRANSMITTERS
- 4 B-SIDE TRANSMITTERS

4 CONTROL PINS
- ENABLE RECEIVER A-SIDE ($\overline{ENRA}$)
- ENABLE RECEIVER B-SIDE ($\overline{ENRB}$)
- ENABLE RECEIVER A-SIDE ($\overline{ENTA}$)
- ENABLE RECEIVERr B-SIDE ($\overline{ENTB}$)

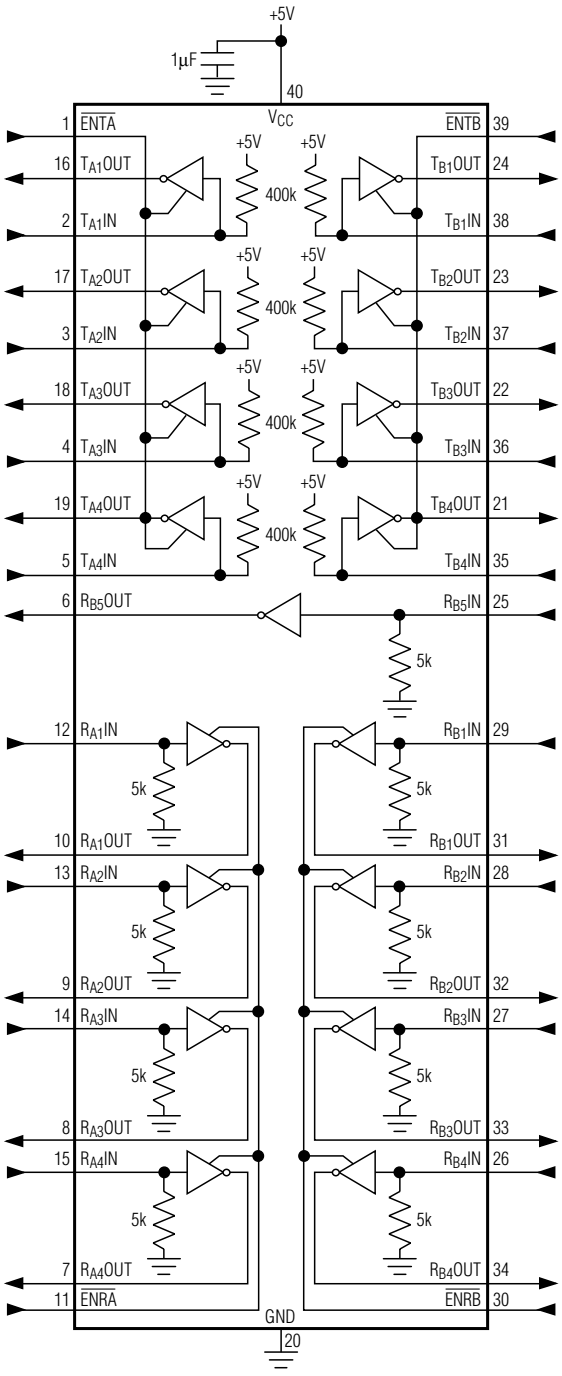
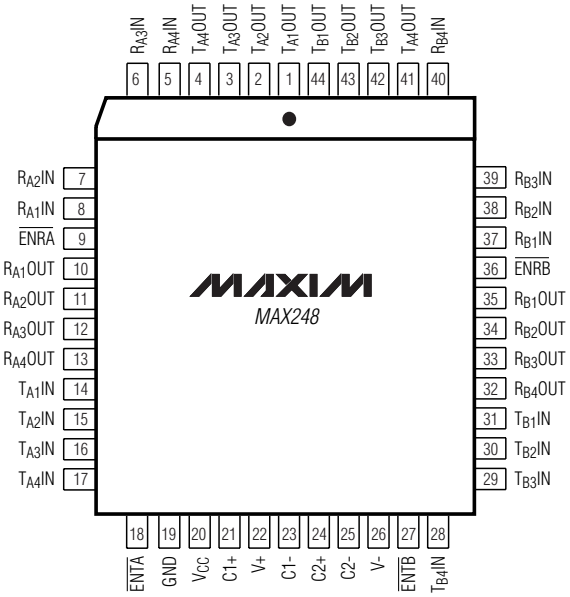
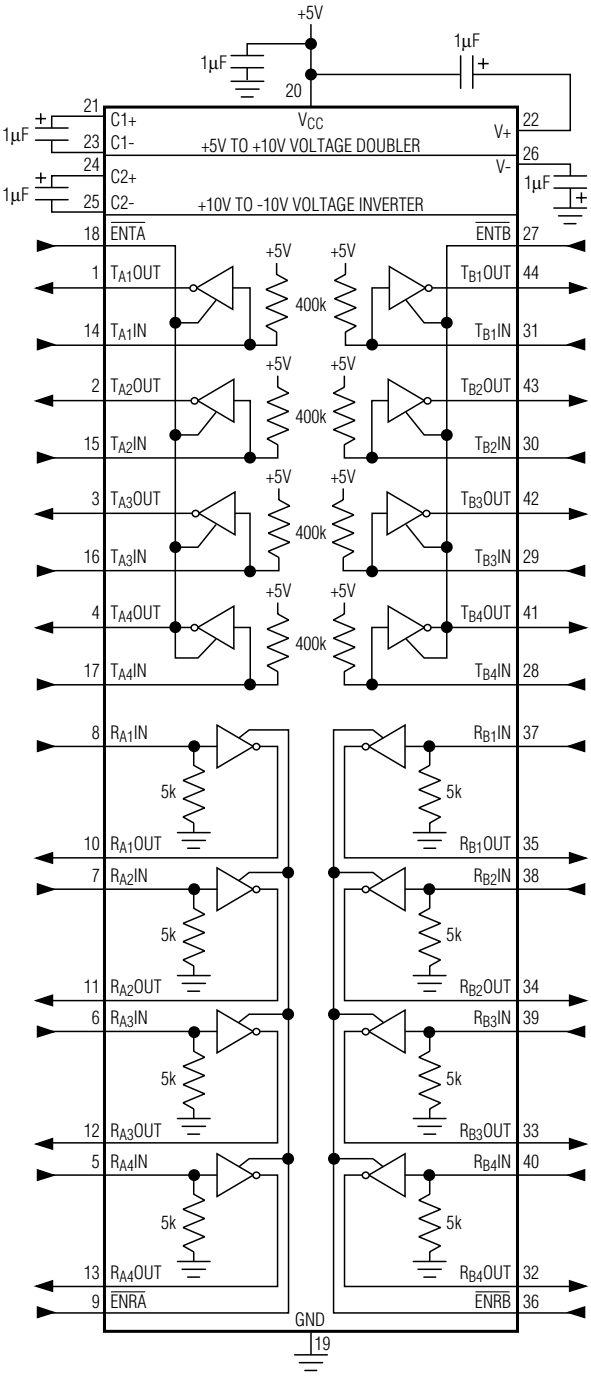


Figure 23. MAX247 Pin Configuration and Typical Operating Circuit

TOP VIEW



PLCC



MAX248 FUNCTIONAL DESCRIPTION

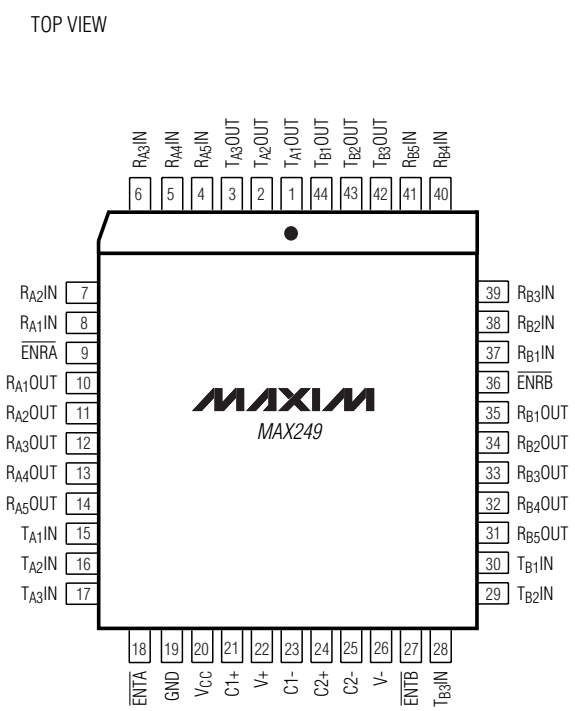
8 RECEIVERS
- 4 A-SIDE RECEIVERS
- 4 B-SIDE RECEIVERS

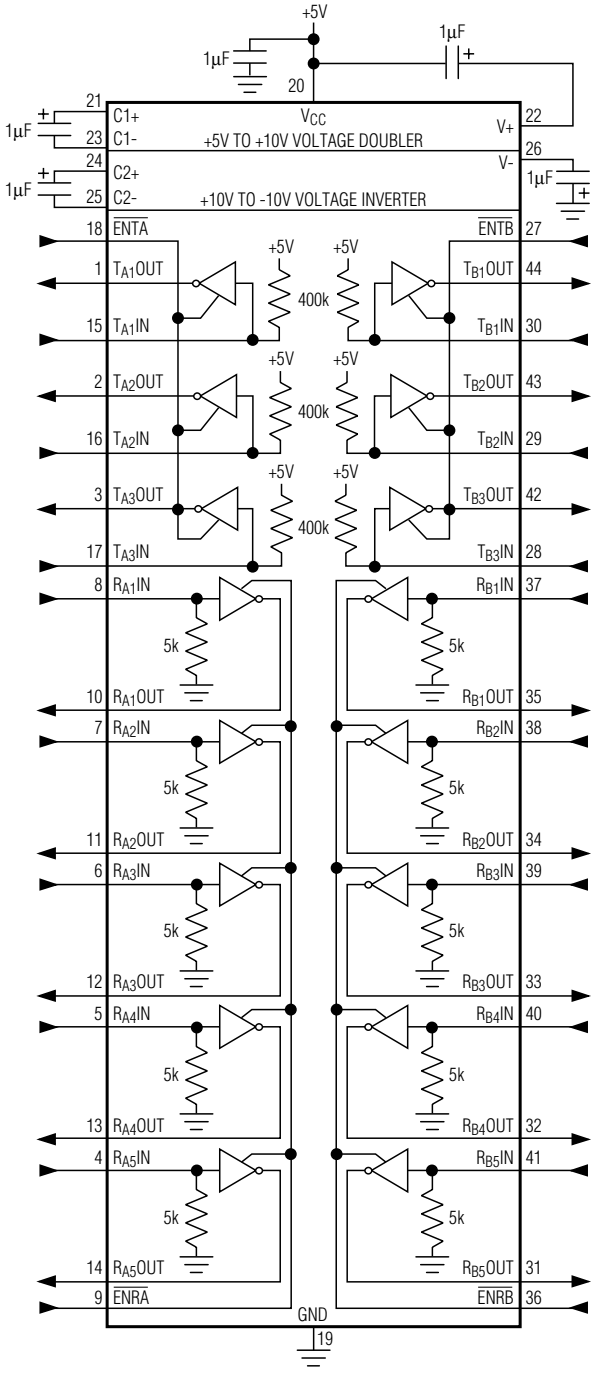
8 TRANSMITTERS
- 4 A-SIDE TRANSMITTERS
- 4 B-SIDE TRANSMITTERS

4 CONTROL PINS
- ENABLE RECEIVER A-SIDE ($\overline{ENRA}$)
- ENABLE RECEIVER B-SIDE ($\overline{ENRB}$)
- ENABLE RECEIVER A-SIDE ($\overline{ENTA}$)
- ENABLE RECEIVER B-SIDE ($\overline{ENTB}$)

Figure 24. MAX248 Pin Configuration and Typical Operating Circuit

+5V-Powered, Multichannel RS-232 Drivers/Receivers





MAX249 FUNCTIONAL DESCRIPTION

10 RECEIVERS
- 5 A-SIDE RECEIVERS
- 5 B-SIDE RECEIVERS

6 TRANSMITTERS
- 3 A-SIDE TRANSMITTERS
- 3 B-SIDE TRANSMITTERS

4 CONTROL PINS
- ENABLE RECEIVER A-SIDE ($\overline{ENRA}$)
- ENABLE RECEIVER B-SIDE ($\overline{ENRB}$)
- ENABLE RECEIVER A-SIDE ($\overline{ENTA}$)
- ENABLE RECEIVER B-SIDE ($\overline{ENTB}$)

Figure 25. MAX249 Pin Configuration and Typical Operating Circuit

Ordering Information (continued)

PART	TEMP. RANGE	PIN-PACKAGE
MAX222CPN	0°C to +70°C	18 Plastic DIP
MAX222CWN	0°C to +70°C	18 Wide SO
MAX222C/D	0°C to +70°C	Dice*
MAX222EPN	-40°C to +85°C	18 Plastic DIP
MAX222EWN	-40°C to +85°C	18 Wide SO
MAX222EJN	-40°C to +85°C	18 CERDIP
MAX222MJN	-55°C to +125°C	18 CERDIP
MAX223CAI	0°C to +70°C	28 SSOP
MAX223CWI	0°C to +70°C	28 Wide SO
MAX223C/D	0°C to +70°C	Dice*
MAX223EAI	-40°C to +85°C	28 SSOP
MAX223EWI	-40°C to +85°C	28 Wide SO
MAX225CWI	0°C to +70°C	28 Wide SO
MAX225EWI	-40°C to +85°C	28 Wide SO
MAX230CPP	0°C to +70°C	20 Plastic DIP
MAX230CWP	0°C to +70°C	20 Wide SO
MAX230C/D	0°C to +70°C	Dice*
MAX230EPP	-40°C to +85°C	20 Plastic DIP
MAX230EWP	-40°C to +85°C	20 Wide SO
MAX230EJP	-40°C to +85°C	20 CERDIP
MAX230MJP	-55°C to +125°C	20 CERDIP
MAX231CPD	0°C to +70°C	14 Plastic DIP
MAX231CWE	0°C to +70°C	16 Wide SO
MAX231CJD	0°C to +70°C	14 CERDIP
MAX231C/D	0°C to +70°C	Dice*
MAX231EPD	-40°C to +85°C	14 Plastic DIP
MAX231EWE	-40°C to +85°C	16 Wide SO
MAX231EJD	-40°C to +85°C	14 CERDIP
MAX231MJD	-55°C to +125°C	14 CERDIP
MAX232CPE	0°C to +70°C	16 Plastic DIP
MAX232CSE	0°C to +70°C	16 Narrow SO
MAX232CWE	0°C to +70°C	16 Wide SO
MAX232C/D	0°C to +70°C	Dice*
MAX232EPE	-40°C to +85°C	16 Plastic DIP
MAX232ESE	-40°C to +85°C	16 Narrow SO
MAX232EWE	-40°C to +85°C	16 Wide SO
MAX232EJE	-40°C to +85°C	16 CERDIP
MAX232MJE	-55°C to +125°C	16 CERDIP
MAX232MLP	-55°C to +125°C	20 LCC
MAX232ACPE	0°C to +70°C	16 Plastic DIP
MAX232ACSE	0°C to +70°C	16 Narrow SO
MAX232ACWE	0°C to +70°C	16 Wide SO
MAX232AC/D	0°C to +70°C	Dice*
MAX232AEPE	-40°C to +85°C	16 Plastic DIP
MAX232AESE	-40°C to +85°C	16 Narrow SO
MAX232AEWE	-40°C to +85°C	16 Wide SO
MAX232AEJE	-40°C to +85°C	16 CERDIP
MAX232AMJE	-55°C to +125°C	16 CERDIP
MAX232AMLP	-55°C to +125°C	20 LCC
MAX233CPP	0°C to +70°C	20 Plastic DIP
MAX233EPP	-40°C to +85°C	20 Plastic DIP
MAX233ACPP	0°C to +70°C	20 Plastic DIP
MAX233ACWP	0°C to +70°C	20 Wide SO
MAX233AEPP	-40°C to +85°C	20 Plastic DIP
MAX233AEWP	-40°C to +85°C	20 Wide SO
MAX234CPE	0°C to +70°C	16 Plastic DIP
MAX234CWE	0°C to +70°C	16 Wide SO
MAX234C/D	0°C to +70°C	Dice*
MAX234EPE	-40°C to +85°C	16 Plastic DIP
MAX234EWE	-40°C to +85°C	16 Wide SO
MAX234EJE	-40°C to +85°C	16 CERDIP
MAX234MJE	-55°C to +125°C	16 CERDIP
MAX235CPG	0°C to +70°C	24 Wide Plastic DIP
MAX235EPG	-40°C to +85°C	24 Wide Plastic DIP
MAX235EDG	-40°C to +85°C	24 Ceramic SB
MAX235MDG	-55°C to +125°C	24 Ceramic SB
MAX236CNG	0°C to +70°C	24 Narrow Plastic DIP
MAX236CWG	0°C to +70°C	24 Wide SO
MAX236C/D	0°C to +70°C	Dice*
MAX236ENG	-40°C to +85°C	24 Narrow Plastic DIP
MAX236EWG	-40°C to +85°C	24 Wide SO
MAX236ERG	-40°C to +85°C	24 Narrow CERDIP
MAX236MRG	-55°C to +125°C	24 Narrow CERDIP
MAX237CNG	0°C to +70°C	24 Narrow Plastic DIP
MAX237CWG	0°C to +70°C	24 Wide SO
MAX237C/D	0°C to +70°C	Dice*
MAX237ENG	-40°C to +85°C	24 Narrow Plastic DIP
MAX237EWG	-40°C to +85°C	24 Wide SO
MAX237ERG	-40°C to +85°C	24 Narrow CERDIP
MAX237MRG	-55°C to +125°C	24 Narrow CERDIP
MAX238CNG	0°C to +70°C	24 Narrow Plastic DIP
MAX238CWG	0°C to +70°C	24 Wide SO
MAX238C/D	0°C to +70°C	Dice*
MAX238ENG	-40°C to +85°C	24 Narrow Plastic DIP

** Contact factory for dice specifications.*

+5V-Powered, Multichannel RS-232 Drivers/Receivers

Ordering Information (continued)

PART	TEMP. RANGE	PIN-PACKAGE
MAX238EWG	-40°C to +85°C	24 Wide SO
MAX238ERG	-40°C to +85°C	24 Narrow CERDIP
MAX238MRG	-55°C to +125°C	24 Narrow CERDIP
MAX239CNG	0°C to +70°C	24 Narrow Plastic DIP
MAX239CWG	0°C to +70°C	24 Wide SO
MAX239C/D	0°C to +70°C	Dice*
MAX239ENG	-40°C to +85°C	24 Narrow Plastic DIP
MAX239EWG	-40°C to +85°C	24 Wide SO
MAX239ERG	-40°C to +85°C	24 Narrow CERDIP
MAX239MRG	-55°C to +125°C	24 Narrow CERDIP
MAX240CMH	0°C to +70°C	44 Plastic FP
MAX240C/D	0°C to +70°C	Dice*
MAX241CAI	0°C to +70°C	28 SSOP
MAX241CWI	0°C to +70°C	28 Wide SO
MAX241C/D	0°C to +70°C	Dice*
MAX241EAI	-40°C to +85°C	28 SSOP
MAX241EWI	-40°C to +85°C	28 Wide SO
MAX242CAP	0°C to +70°C	20 SSOP
MAX242CPN	0°C to +70°C	18 Plastic DIP
MAX242CWN	0°C to +70°C	18 Wide SO
MAX242C/D	0°C to +70°C	Dice*
MAX242EPN	-40°C to +85°C	18 Plastic DIP
MAX242EWN	-40°C to +85°C	18 Wide SO
MAX242EJN	-40°C to +85°C	18 CERDIP
MAX242MJN	-55°C to +125°C	18 CERDIP
MAX243CPE	0°C to +70°C	16 Plastic DIP
MAX243CSE	0°C to +70°C	16 Narrow SO
MAX243CWE	0°C to +70°C	16 Wide SO
MAX243C/D	0°C to +70°C	Dice*
MAX243EPE	-40°C to +85°C	16 Plastic DIP
MAX243ESE	-40°C to +85°C	16 Narrow SO
MAX243EWE	-40°C to +85°C	16 Wide SO
MAX243EJE	-40°C to +85°C	16 CERDIP
MAX243MJE	-55°C to +125°C	16 CERDIP
MAX244CQH	0°C to +70°C	44 PLCC
MAX244C/D	0°C to +70°C	Dice*
MAX244EQH	-40°C to +85°C	44 PLCC
MAX245CPL	0°C to +70°C	40 Plastic DIP
MAX245C/D	0°C to +70°C	Dice*
MAX245EPL	-40°C to +85°C	40 Plastic DIP
MAX246CPL	0°C to +70°C	40 Plastic DIP
MAX246C/D	0°C to +70°C	Dice*
MAX246EPL	-40°C to +85°C	40 Plastic DIP
MAX247CPL	0°C to +70°C	40 Plastic DIP
MAX247C/D	0°C to +70°C	Dice*
MAX247EPL	-40°C to +85°C	40 Plastic DIP
MAX248CQH	0°C to +70°C	44 PLCC
MAX248C/D	0°C to +70°C	Dice*
MAX248EQH	-40°C to +85°C	44 PLCC
MAX249CQH	0°C to +70°C	44 PLCC
MAX249EQH	-40°C to +85°C	44 PLCC

** Contact factory for dice specifications.*

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HD-6402

CMOS Universal Asynchronous Receiver Transmitter (UART)

March 1997

Features

- **8.0MHz Operating Frequency (HD-6402B)**
- **2.0MHz Operating Frequency (HD-6402R)**
- **Low Power CMOS Design**
- **Programmable Word Length, Stop Bits and Parity**
- **Automatic Data Formatting and Status Generation**
- **Compatible with Industry Standard UARTs**
- **Single +5V Power Supply**
- **CMOS/TTL Compatible Inputs**

Description

The HD-6402 is a CMOS UART for interfacing computers or microprocessors to an asynchronous serial data channel. The receiver converts serial start, data, parity and stop bits. The transmitter converts parallel data into serial form and automatically adds start, parity and stop bits. The data word length can be 5, 6, 7 or 8 bits. Parity may be odd or even. Parity checking and generation can be inhibited. The stop bits may be one or two or one and one-half when transmitting 5-bit code.

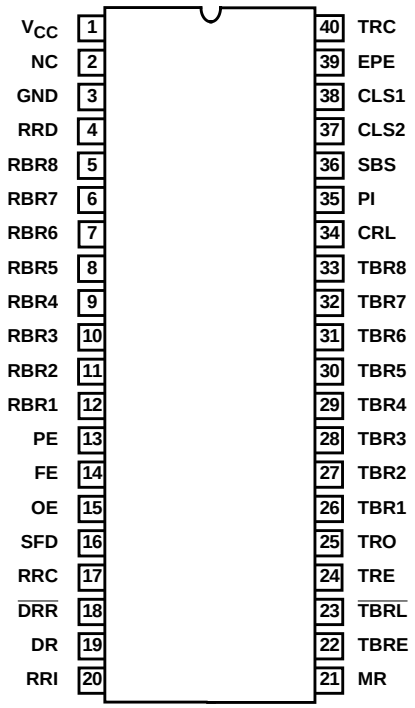
The HD-6402 can be used in a wide range of applications including modems, printers, peripherals and remote data acquisition systems. Utilizing the Intersil advanced scaled SAJI IV CMOS process permits operation clock frequencies up to 8.0MHz (500K Baud). Power requirements, by comparison, are reduced from 300mW to 10mW. Status logic increases flexibility and simplifies the user interface.

Ordering Information

PACKAGE	TEMPERATURE RANGE	2MHz = 125K BAUD	8MHz = 500K BAUD	PKG. NO.
Plastic DIP	-40^{o}C to +85^{o}C	HD3-6402R-9	HD3-6402B-9	E40.6
CERDIP	-40^{o}C to +85^{o}C	HD1-6402R-9	HD1-6402B-9	F40.6
SMD#	-55^{o}C to +125^{o}C	5962-9052501MQA	5962-9052502MQA	F40.6

Pinout

HD-6402 (PDIP, CERDIP)
TOP VIEW



CAUTION: These devices are sensitive to electrostatic discharge; follow proper IC Handling Procedures.
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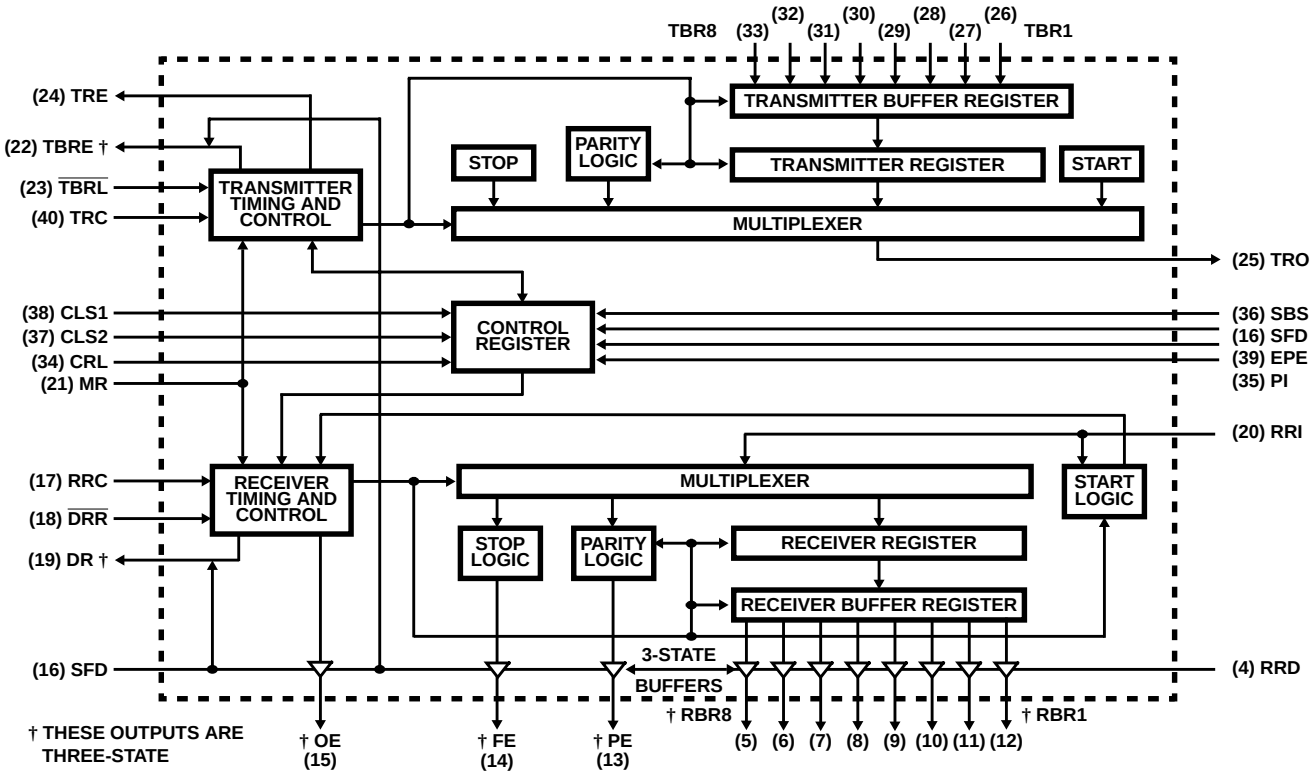
File Number **2956.1**

Functional Diagram



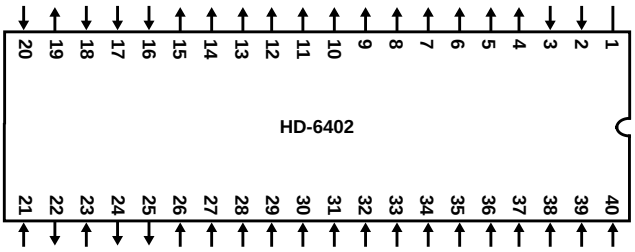
Control Definition

CONTROL WORD					CHARACTER FORMAT			
CLS 2	CLS 1	PI	EPE	SBS	START BIT	DATA BITS	PARITY BIT	STOP BITS
0	0	0	0	0	1	5	ODD	1
0	0	0	0	1	1	5	ODD	1.5
0	0	0	1	0	1	5	EVEN	1
0	0	0	1	1	1	5	EVEN	1.5
0	0	1	X	0	1	5	NONE	1
0	0	1	X	1	1	5	NONE	1.5
0	1	0	0	0	1	6	ODD	1
0	1	0	0	1	1	6	ODD	2
0	1	0	1	0	1	6	EVEN	1
0	1	0	1	1	1	6	EVEN	2
0	1	1	X	0	1	6	NONE	1
0	1	1	x	1	1	6	NONE	2
1	0	0	0	0	1	7	ODD	1
1	0	0	0	1	1	7	ODD	2
1	0	0	1	0	1	7	EVEN	1
1	0	0	1	1	1	7	EVEN	2
1	0	1	X	0	1	7	NONE	1
1	0	1	x	1	1	7	NONE	2
1	1	0	0	0	1	8	ODD	1
1	1	0	0	1	1	8	ODD	2
1	1	0	1	0	1	8	EVEN	1
1	1	0	1	1	1	8	EVEN	2
1	1	1	X	0	1	8	NONE	1
1	1	1	x	1	1	8	NONE	2

Pin Description

PIN	TYPE	SYMBOL	DESCRIPTION
1		V_{CC} †	Positive Voltage Supply
2		NC	No Connection
3		GND	Ground
4	I	RRD	A high level on RECEIVER REGISTER DISABLE forces the receiver holding out-puts RBR1-RBR8 to high impedance state.
5	O	RBR8	The contents of the RECEIVER BUFFER REGISTER appear on these three-state outputs. Word formats less than 8 characters are right justified to RBR1.
6	O	RBR7	See Pin 5-RBR8
7	O	RBR6	See Pin 5-RBR8
8	O	RBR5	See Pin 5-RBR8
9	O	RBR4	See Pin 5-RBR8
10	O	RBR3	See Pin 5-RBR8
11	O	RBR2	See Pin 5-RBR8
12	O	RBR1	See Pin 5-RBR8
13	O	PE	A high level on PARITY ERROR indicates received parity does not match parity programmed by control bits. When parity is inhibited this output is low.
14	O	FE	A high level on FRAMING ERROR indicates the first stop bit was invalid.
15	O	OE	A high level on OVERRUN ERROR indicates the data received flag was not cleared before the last character was transferred to the receiver buffer register.
16	I	SFD	A high level on STATUS FLAGS DISABLE forces the outputs PE, FE, OE, DR, TBRE to a high impedance state.
17	I	RRC	The Receiver register clock is 16X the receiver data rate.
18	I	$\overline{DRR}$	A low level on DATA RECEIVED RESET clears the data received output DR to a low level.
19	O	DR	A high level on DATA RECEIVED indicates a character has been received and transferred to the receiver buffer register.
20	I	RRI	Serial data on RECEIVER REGISTER INPUT is clocked into the receiver register.
21	I	MR	A high level on MASTER RESET clears PE, FE, OE and DR to a low level and sets the transmitter register empty (TRE) to a high level 18 clock cycles after MR falling edge. MR does not clear the receiver buffer register. This input must be pulsed at least once after power up. The HD-6402 must be master reset after power up. The reset pulse should meet V_{IH} and t_{MR}. Wait 18 clock cycles after the falling edge of MR before beginning operation.
22	O	TBRE	A high level on TRANSMITTER BUFFER REGISTER EMPTY indicates the transmitter buffer register has transferred its data to the transmitter register and is ready for new data.
23	I	$\overline{TBRL}$	A low level on TRANSMITTER BUFFER REGISTER LOAD transfers data from inputs TBR1-TBR8 into the transmitter buffer register. A low to high transition on $\overline{TBRL}$ initiates data transfer to the transmitter register. If busy, transfer is automatically delayed so that the two characters are transmitted end to end.
24	O	TRE	A high level on TRANSMITTER REGISTER EMPTY indicates completed transmission of a character including stop bits.
25	O	TRO	Character data, start data and stop bits appear serially at the TRANSMITTER REGISTER OUTPUT.
26	I	TRB1	Character data is loaded into the TRANSMITTER BUFFER REGISTER via inputs TBR1-TBR8. For character formats less than 8 bits the TBR8, 7 and 6 inputs are ignored corresponding to their programmed word length.
27	I	TBR2	See Pin 26-TBR1.
28	I	TBR3	See Pin 26-TBR1.
29	I	TBR4	See Pin 26-TBR1.
30	I	TBR5	See Pin 26-TBR1.
31	I	TBR6	See Pin 26-TBR1.
32	I	TBR7	See Pin 26-TBR1.
33	I	TBR8	See Pin 26-TBR1.
34	I	CRL	A high level on CONTROL REGISTER LOAD loads the control register with the control word. The control word is latched on the falling edge of CRL. CRL may be tied high.
35	I	PI	A high level on PARITY INHIBIT inhibits parity generation, parity checking and forces PE output low.
36	I	SBS	A high level on STOP BIT SELECT selects 1.5 stop bits for 5 character format and 2 stop bits for other lengths.
37	I	CLS2	These inputs program the CHARACTER LENGTH SELECTED (CLS1 low CLS2 low 5 bits) (CLS1 high CLS2 low 6 bits) (CLS1 low CLS2 high 7 bits) (CLS1 high CLS2 high 8 bits.)
38	I	CLS1	See Pin 37-CLS2.
39	I	EPE	When PI is low, a high level on EVEN PARITY ENABLE generates and checks even parity. A low level selects odd parity.
40	I	TRC	The TRANSMITTER REGISTER CLOCK is 16X the transmit data rate.

† A 0.1µF decoupling capacitor from the V_{CC} pin to the GND is recommended.



Transmitter Operation

The transmitter section accepts parallel data, formats the data and transmits the data in serial form on the Transmitter Register Output (TRO) terminal (See serial data format). Data is loaded from the inputs TBR1-TBR8 into the Transmitter Buffer Register by applying a logic low on the Transmitter Buffer Register Load ($\overline{TBRL}$) input (A). Valid data must be present at least t_{set} prior to and t_{hold} following the rising edge of $\overline{TBRL}$. If words less than 8 bits are used, only the least significant bits are transmitted. The character is right justified, so the least significant bit corresponds to TBR1 (B).

The rising edge of $\overline{TBRL}$ clears Transmitter Buffer Register Empty (TBRE). 0 to 1 Clock cycles later, data is transferred to the transmitter register, the Transmitter Register Empty (TRE) pin goes to a low state, TBRE is set high and serial data information is transmitted. The output data is clocked by Transmitter Register Clock (TRC) at a clock rate 16 times the data rate. A second low level pulse on $\overline{TBRL}$ loads data into the Transmitter Buffer Register (C). Data transfer to the transmitter register is delayed until transmission of the current data is complete (D). Data is automatically transferred to the transmitter register and transmission of that character begins one clock cycle later.

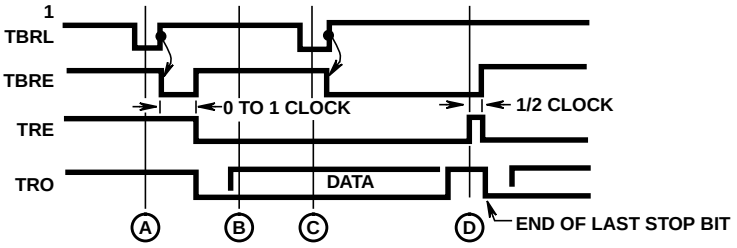


FIGURE 1. TRANSMITTER TIMING (NOT TO SCALE)

Receiver Operation

Data is received in serial form at the Receiver Register Input (RRI). When no data is being received, RRI must remain high. The data is clocked through the Receiver Register Clock (RRC). The clock rate is 16 times the data rate. A low level on Data Received Reset ($\overline{DRR}$) clears the Data Receiver (DR) line (A). During the first stop bit data is transferred from the Receiver Register to the Receiver Buffer Register (RBR) (B). If the word is less than 8 bits, the unused most significant bits will be a logic low. The output character is right justified to the least significant bit RBR1. A logic high on Overrun Error (OE) indicates overruns. An overrun occurs when DR has not been cleared before the present character was transferred to the RBR. One clock cycle later DR is reset to a logic high, and Framing Error (FE) is evaluated (C). A logic high on FE indicates an invalid stop bit was received, a framing error. A logic high on Parity Error (PE) indicates a parity error.

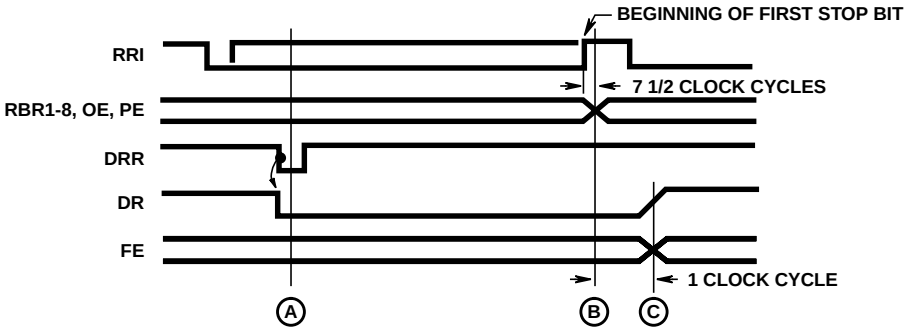


FIGURE 2. RECEIVER TIMING (NOT TO SCALE)

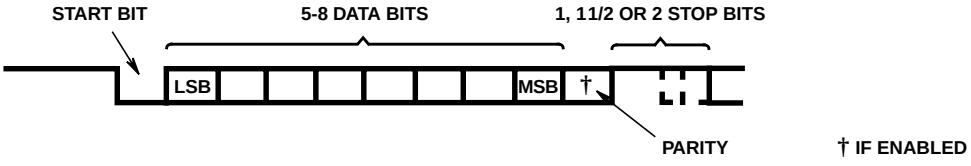


FIGURE 3. SERIAL DATA FORMAT

Start Bit Detection

The receiver uses a 16X clock timing. The start bit could have occurred as much as one clock cycle before it was detected, as indicated by the shaded portion (A). The center of the start bit is defined as clock count 7 1/2. If the receiver clock is a symmetrical square wave, the center of the start bit will be located within ±1/2 clock cycle, ±1/32 bit or 3.125% giving a receiver margin of 46.875%. The receiver begins searching for the next start bit at the center of the first stop bit.

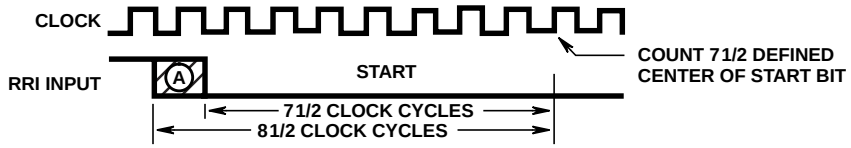


FIGURE 4.

Interfacing with the HD-6402

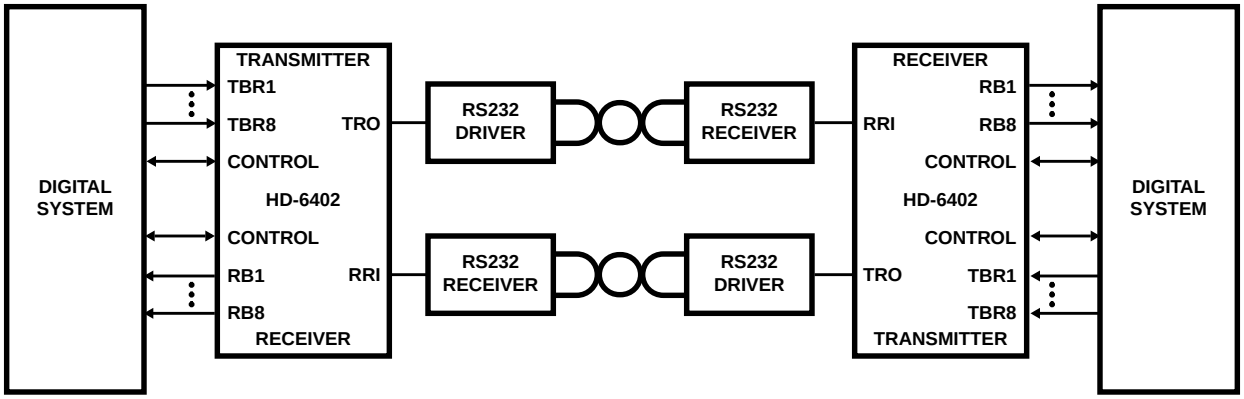


FIGURE 5. TYPICAL SERIAL DATA LINK

Absolute Maximum Ratings

Supply Voltage . . . . . +8.0V
Input, Output or I/O Voltage Applied . . . . . GND -0.5V to V_{CC} +0.5V
Storage Temperature Range . . . . . -65^oC to $+150^oC$
Junction Temperature . . . . . $+175^oC$
Lead Temperature (Soldering 10s) . . . . . $+300^oC$
ESD Classification . . . . . Class 1
Typical Derating Factor . . . . . 1mA/MHz Increase in ICCOP

Thermal Information

Thermal Resistance (Typical)	θ_{JA}	θ_{JC}
CERDIP Package	$50^oC/W$	$12^oC/W$
PDIP Package	$50^oC/W$	N/A

Gate Count . . . . . 1643 Gates

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

Operating Conditions

Operating Voltage Range . . . . . +4.5V to +5.5V

Operating Temperature Range
HD-6402R-9, HD6402B-9 . . . . . -40^oC to $+85^oC$

DC Electrical Specifications $V_{CC} = 5.0V \pm 10\%$, $T_A = -40^oC$ to $+85^oC$ (HD-6402R-9, HD-6402B-9)

SYMBOL	PARAMETER	LIMITS MIN	LIMITS MAX	UNITS	CONDITIONS
V_{IH}	Logical "1" Input Voltage	2.0	-	V	V_{CC} = 5.5V
V_{IL}	Logical "0" Input Voltage	-	0.8	V	V_{CC} = 4.5V
II	Input Leakage Current	-1.0	1.0	µA	V_{IN} = GND or V_{CC}, V_{CC} = 5.5V
V_{OH}	Logical "1" Output Voltage	3.0 V_{CC} -0.4	- -	V	I_{OH} = -2.5mA, V_{CC} = 4.5V I_{OH} = -100µA
V_{OL}	Logical "0" Output Voltage	-	0.4	V	I_{OL} = +2.5mA, V_{CC} = 4.5V
I_O	Output Leakage Current	-1.0	1.0	µA	V_O = GND or V_{CC}, V_{CC} = 5.5V
ICCSB	Standby Supply Current	-	100	µA	V_{IN} = GND or V_{CC}; V_{CC} = 5.5V, Output Open
ICCOP	Operating Supply Current (See Note)	-	2.0	mA	V_{CC} = 5.5V, Clock Freq. = 2MHz, V_{IN} = V_{CC} or GND, Outputs Open

NOTE: Guaranteed, but not 100% tested

Capacitance $T_A = +25^oC$

PARAMETER	SYMBOL	CONDITIONS	LIMIT TYPICAL	UNITS
Input Capacitance	CIN	Freq. = 1MHz, all measurements are referenced to device GND	25	pF
Output Capacitance	COUT		25	pF

AC Electrical Specifications $V_{CC} = 5.0V \pm 10\%$, $T_A = -40^oC$ to $+85^oC$ (HD-6402R-9, HD6402B-9)

SYMBOL	PARAMETER	LIMITS HD-6402R MIN	LIMITS HD-6402R MAX	LIMITS HD-6402B MIN	LIMITS HD-6402B MAX	UNITS	CONDITIONS
(1) fCLOCK	Clock Frequency	D.C.	2.0	D.C.	8.0	MHz	C_L = 50pF See Switching Waveform
(2) t_{PW}	Pulse Widths, CRL, DRR, TBRL	150	-	75	-	ns	
(3) t_{MR}	Pulse Width MR	150	-	150	-	ns	
(4) t_{SET}	Input Data Setup Time	50	-	20	-	ns	
(5) t_{HOLD}	Input Data Hold Time	60	-	20	-	ns	
(6) t_{EN}	Output Enable Time	-	160	-	35	ns	

Switching Waveforms

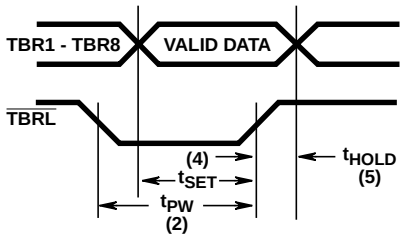


FIGURE 6. DATA INPUT CYCLE

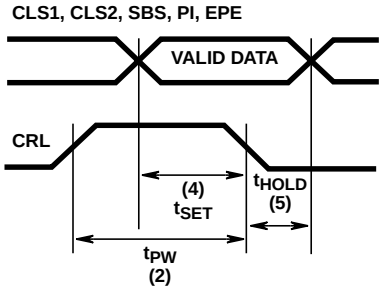


FIGURE 7. CONTROL REGISTER LOAD CYCLE

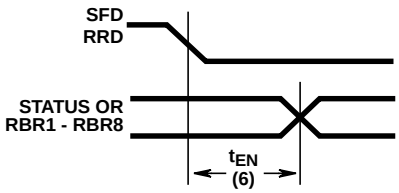


FIGURE 8. STATUS FLAG OUTPUT ENABLE TIME OR DATA OUTPUT ENABLE TIME

A.C. Testing Input, Output Waveform

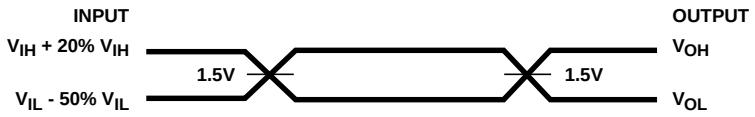


FIGURE 9.

NOTE: A.C. Testing: All input signals must switch between V_{IL} - 50% V_{IL} and V_{IH} + 20% V_{IH}. Input rise and fall times are driven at 1ns/V.

Test Circuit

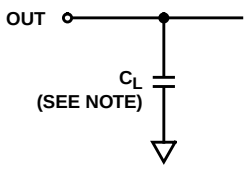


FIGURE 10.

NOTE: Includes stray and jig capacitance, C_L = 50pF.

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MOTOROLA

MC4741C

Differential Input Operational Amplifier

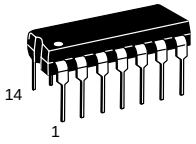
The MC4741C is a true quad MC1741. Integrated on a single monolithic chip are four independent, low power operational amplifiers which have been designed to provide operating characteristics identical to those of the industry standard MC1741, and can be applied with no change in circuit performance.

The MC4741C can be used in applications where amplifier matching or high packing density is important. Other applications include high impedance buffer amplifiers and active filter amplifiers.

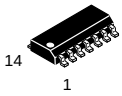
- Each Amplifier is Functionally Equivalent to the MC1741
- Class AB Output Stage Eliminates Crossover Distortion
- True Differential Inputs
- Internally Frequency Compensated
- Short Circuit Protection
- Low Power Supply Current (0.6 mA/Amplifier)

DIFFERENTIAL INPUT OPERATIONAL AMPLIFIER
(QUAD MC1741)

SEMICONDUCTOR TECHNICAL DATA

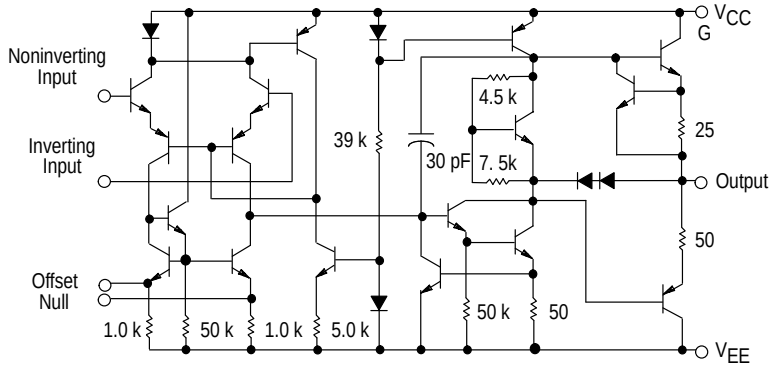


P SUFFIX
PLASTIC PACKAGE
CASE 646

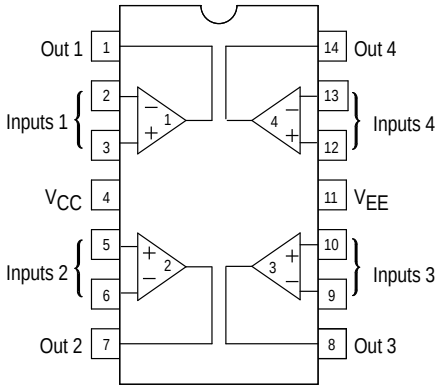


D SUFFIX
PLASTIC PACKAGE
CASE 751A
(SO–14)

Representative Schematic Diagram
(1/4 of Circuit Shown)



PIN CONNECTIONS



(Top View)

ORDERING INFORMATION

Device	Operating Temperature Range	Package
MC4741CD	T_A = 0° to +70°C	SO–14
MC4741CP		Plastic DIP

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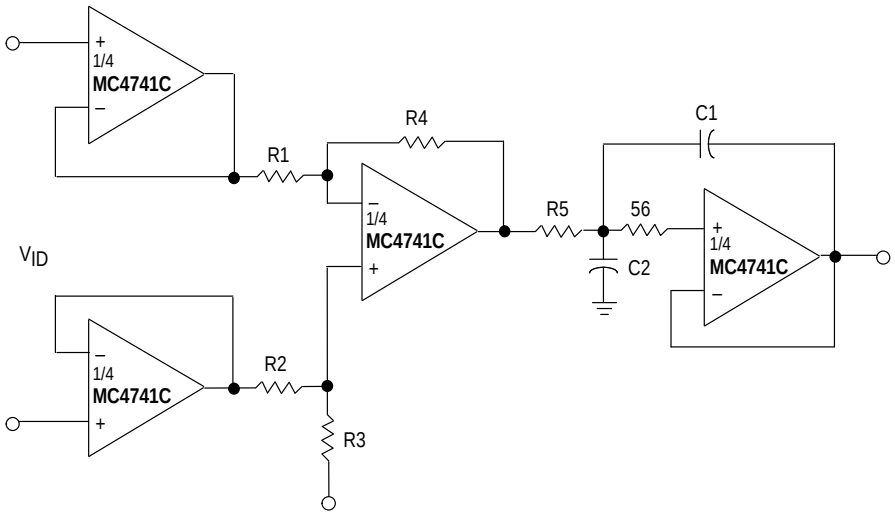
MAXIMUM RATINGS (T_A = +25°C, unless otherwise noted.)

Rating	Symbol	Value	Unit
Power Supply Voltage	V_{CC} V_{EE}	+18 –18	Vdc
Input Differential Voltage	V_{ID}	±36	V
Input Common Mode Voltage	V_{ICM}	±18	V
Output Short Circuit Duration	t_{SC}	Continuous	
Operating Ambient Temperature Range	T_A	0 to +70	°C
Storage Temperature Range	T_{stg}	–55 to +125	°C
Junction Temperature	T_J	150	°C

High Impedance Instrumentation Buffer/Filter



ELECTRICAL CHARACTERISTICS (V_{CC} = +15 V, V_{EE} = –15 V, T_A = 25°C, unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
Input Offset Voltage ($R_S \le 10$ k)	V_{IO}	–	2.0	6.0	mV
Input Offset Current	I_{IO}	–	20	200	nA
Input Bias Current	I_{IB}	–	80	500	nA
Input Resistance	r_i	0.3	2.0	–	MΩ
Input Capacitance	C_i	–	1.4	–	pF
Offset Voltage Adjustment Range	V_{IOR}	–	±15	–	mV
Common Mode Input Voltage Range	V_{ICR}	±12	±13	–	V
Large Signal Voltage Gain (V_O = ±10 V, $R_L \ge 2.0$ k)	A_v	20	200	–	V/mV
Output Resistance	r_o	–	75	–	Ω
Common Mode Rejection ($R_S \le 10$ k)	CMR	70	90	–	dB
Supply Voltage Rejection Ratio ($R_S \le 10$ k)	PSRR	–	30	150	μV/V
Output Voltage Swing ($R_L \ge 10$ k) ($R_L \ge 2$ k)	V_O	 ±12 ±10	 ±14 ±13	 – –	V
Output Short Circuit Current	I_{SC}	–	20	–	mA
Supply Current – (All Amplifiers)	I_D	–	3.5	7.0	mA
Power Consumption (All Amplifiers)	P_C	–	105	210	mW
Transient Response (Unity Gain – Non–Inverting) (V_I = 20 mV, $R_L \ge 2$ kΩ, $C_L \le 100$ pF) Rise Time (V_I = 20 mV, $R_L \ge 2$ kΩ, $C_L \le 100$ pF) Overshoot (V_I = 10 V, $R_L \ge 2$ kΩ, $C_L \le 100$ pF) Slew Rate	 t_{TLH} os SR	 – – –	 0.3 15 0.5	 – – –	 μs % V/μs

ELECTRICAL CHARACTERISTICS (V_{CC} = +15 V, V_{EE} = –15 V, T_A = * T_{high} to T_{low}, unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
Input Offset Voltage ($R_S \le 10$ kΩ)	V_{IO}	–	–	7.5	mV
Input Offset Current (T_A = 0° to + 70°C)	I_{IO}	–	–	300	nA
Input Bias Current (T_A = 0° to + 70°C)	I_{IB}	–	–	800	nA
Large Signal Voltage Gain ($R_L \ge 2$k, V_{OUT} = ±10 V)	A_V	15	–	–	V/mV
Output Voltage Swing ($R_L \ge 2$ k)	V_O	±10	±13	–	V

* T_{high} = 70°C T_{low} = –0°C

Figure 1. Power Bandwidth (Large Signal Swing versus Frequency)

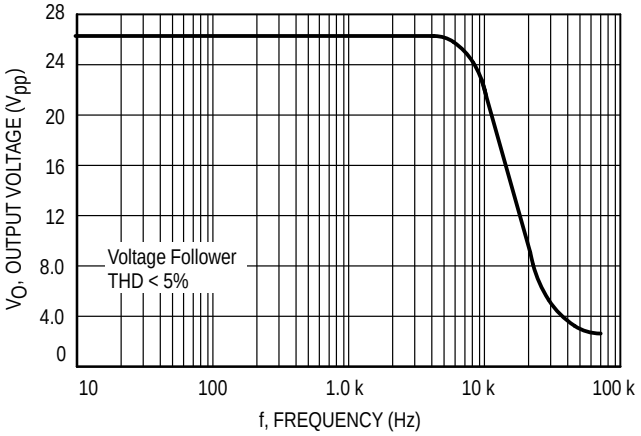


Figure 2. Open Loop Frequency Response

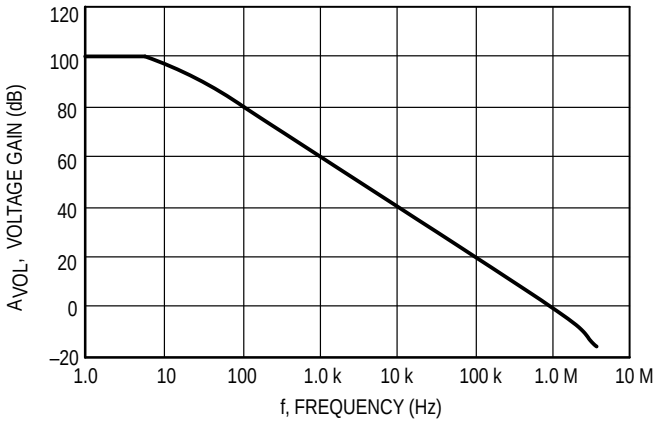


Figure 3. Positive Output Voltage Swing versus Load Resistance

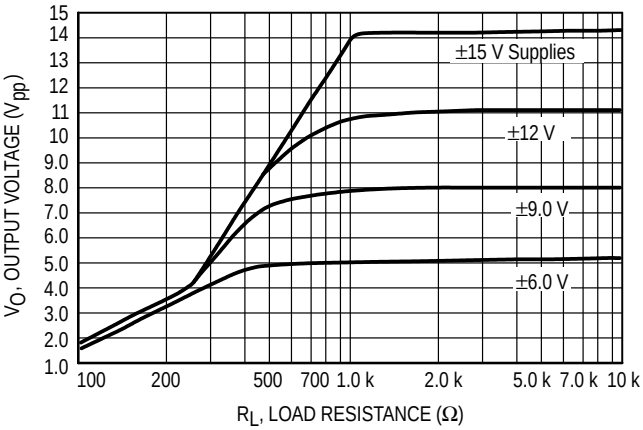


Figure 4. Negative Output Voltage Swing versus Load Resistance

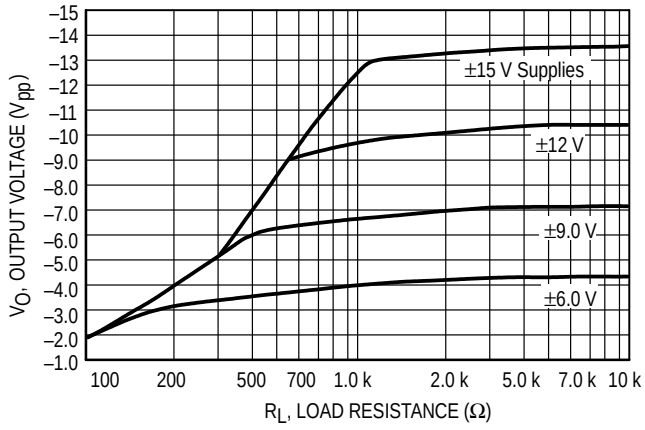


Figure 5. Output Voltage Swing versus Load Resistance (Single Supply Operation)

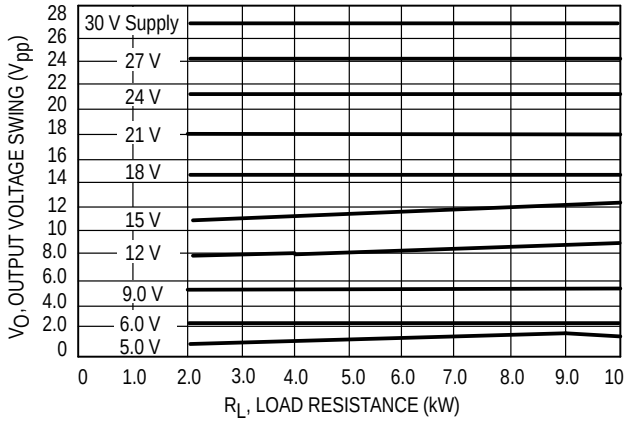


Figure 6. Noninverting Pulse Response

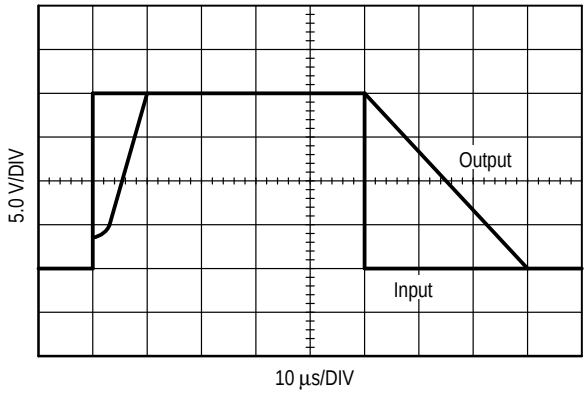


Figure 7. Bi–Quad Filter

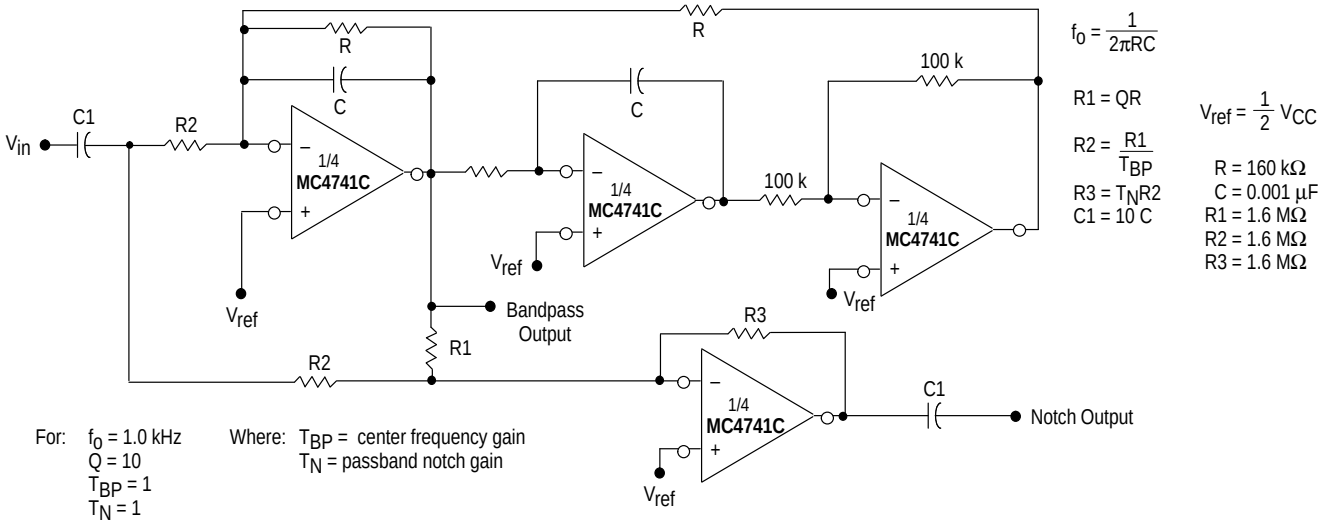


Figure 8. Open Loop Voltage Gain versus Supply Voltage

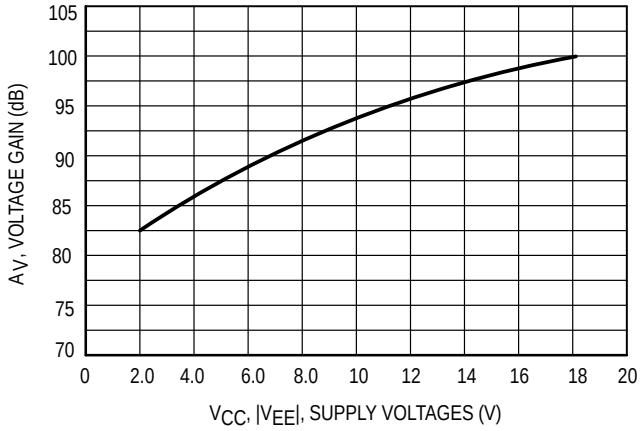


Figure 9. Transient Response Test Circuit

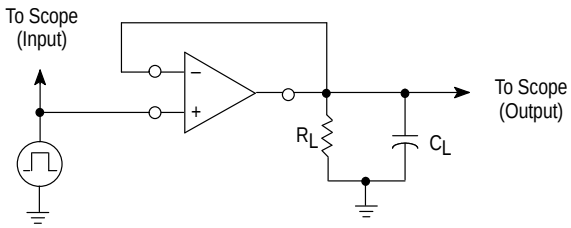
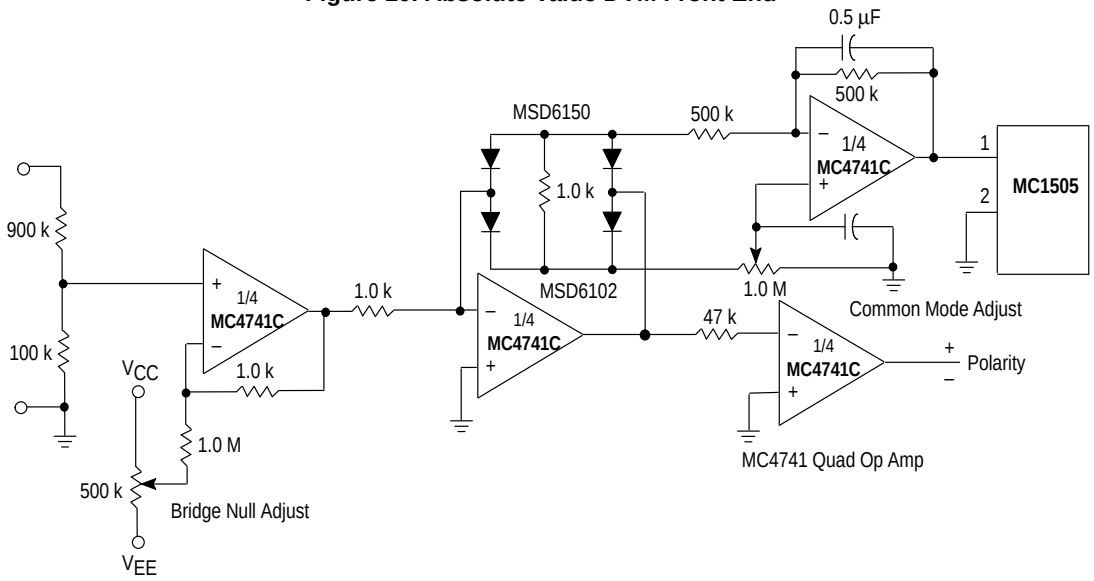
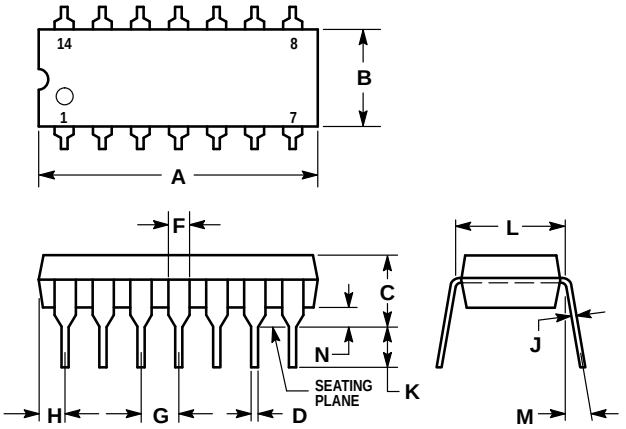


Figure 10. Absolute Value DVM Front End



OUTLINE DIMENSIONS

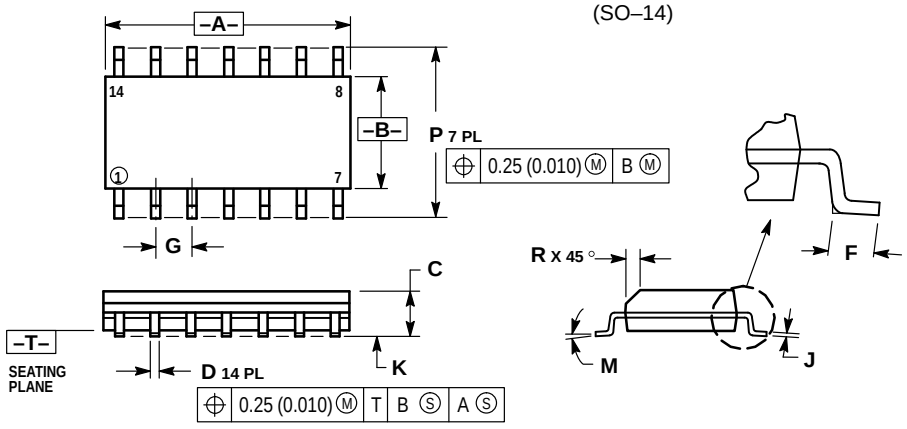
P SUFFIX
PLASTIC PACKAGE
CASE 646–06
ISSUE L



NOTES:
1. LEADS WITHIN 0.13 (0.005) RADIUS OF TRUE POSITION AT SEATING PLANE AT MAXIMUM MATERIAL CONDITION.
2. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
3. DIMENSION B DOES NOT INCLUDE MOLD FLASH.
4. ROUNDED CORNERS OPTIONAL.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.715	0.770	18.16	19.56
B	0.240	0.260	6.10	6.60
C	0.145	0.185	3.69	4.69
D	0.015	0.021	0.38	0.53
F	0.040	0.070	1.02	1.78
G	0.100 BSC		2.54 BSC	
H	0.052	0.095	1.32	2.41
J	0.008	0.015	0.20	0.38
K	0.115	0.135	2.92	3.43
L	0.300 BSC		7.62 BSC	
M	0°	10°	0°	10°
N	0.015	0.039	0.39	1.01

D SUFFIX
PLASTIC PACKAGE
CASE 751A–03
ISSUE F
(SO–14)



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	8.55	8.75	0.337	0.344
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 BSC		0.050 BSC	
J	0.19	0.25	0.008	0.009
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	5.80	6.20	0.228	0.244
R	0.25	0.50	0.010	0.019

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National Semiconductor

August 1999

LM35
Precision Centigrade Temperature Sensors

General Description

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ˚ Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±¼˚C at room temperature and ±¾˚C over a full −55 to +150˚C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1˚C in still air. The LM35 is rated to operate over a −55˚ to +150˚C temperature range, while the LM35C is rated for a −40˚ to +110˚C range (−10˚ with improved accuracy). The LM35 series is available packaged in hermetic TO-46 transistor packages, while the LM35C, LM35CA, and LM35D are also available in the plastic TO-92 transistor package. The LM35D is also available in an 8-lead surface mount small outline package and a plastic TO-220 package.

Features

- Calibrated directly in ˚ Celsius (Centigrade)
- Linear + 10.0 mV/˚C scale factor
- 0.5˚C accuracy guaranteeable (at +25˚C)
- Rated for full −55˚ to +150˚C range
- Suitable for remote applications
- Low cost due to wafer-level trimming
- Operates from 4 to 30 volts
- Less than 60 µA current drain
- Low self-heating, 0.08˚C in still air
- Nonlinearity only ±¼˚C typical
- Low impedance output, 0.1 Ω for 1 mA load

Typical Applications

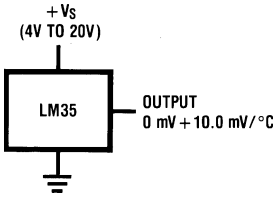
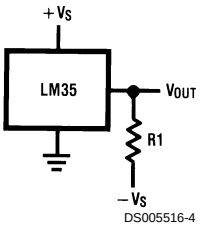


FIGURE 1. Basic Centigrade Temperature Sensor (+2˚C to +150˚C)



Choose $R_1 = -V_S/50\ \mu A$

V_{OUT} = +1,500 mV at +150˚C
= +250 mV at +25˚C
= −550 mV at −55˚C

FIGURE 2. Full-Range Centigrade Temperature Sensor

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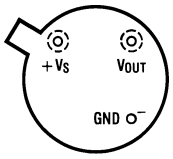
Connection Diagrams

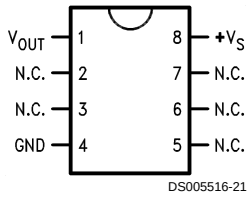
TO-46
Metal Can Package*



*Case is connected to negative pin (GND)

Order Number LM35H, LM35AH, LM35CH, LM35CAH or LM35DH
See NS Package Number H03H

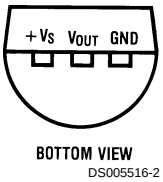
SO-8
Small Outline Molded Package



N.C. = No Connection

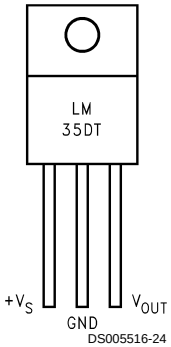
Top View
Order Number LM35DM
See NS Package Number M08A

TO-92
Plastic Package



Order Number LM35CZ, LM35CAZ or LM35DZ
See NS Package Number Z03A

TO-220
Plastic Package*



*Tab is connected to the negative pin (GND).

Note: The LM35DT pinout is different than the discontinued LM35DP.

Order Number LM35DT
See NS Package Number TA03F

Absolute Maximum Ratings (Note 10)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

Supply Voltage	+35V to −0.2V
Output Voltage	+6V to −1.0V
Output Current	10 mA
Storage Temp.;	
TO-46 Package,	−60˚C to +180˚C
TO-92 Package,	−60˚C to +150˚C
SO-8 Package,	−65˚C to +150˚C
TO-220 Package,	−65˚C to +150˚C
Lead Temp.:	
TO-46 Package, (Soldering, 10 seconds)	300˚C
TO-92 and TO-220 Package, (Soldering, 10 seconds)	260˚C
SO Package (Note 12)	
Vapor Phase (60 seconds)	215˚C
Infrared (15 seconds)	220˚C
ESD Susceptibility (Note 11)	2500V
Specified Operating Temperature Range: T_{MIN} to T_{MAX} (Note 2)	
LM35, LM35A	−55˚C to +150˚C
LM35C, LM35CA	−40˚C to +110˚C
LM35D	0˚C to +100˚C

Electrical Characteristics

(Notes 1, 6)

Parameter	Conditions	LM35A			LM35CA			Units (Max.)
		Typical	Tested Limit (Note 4)	Design Limit (Note 5)	Typical	Tested Limit (Note 4)	Design Limit (Note 5)	
Accuracy	T_A=+25˚C	±0.2	±0.5		±0.2	±0.5		˚C
(Note 7)	T_A=−10˚C	±0.3			±0.3		±1.0	˚C
	T_A=T_{MAX}	±0.4	±1.0		±0.4	±1.0		˚C
	T_A=T_{MIN}	±0.4	±1.0		±0.4		±1.5	˚C
Nonlinearity (Note 8)	T_{MIN}≤T_A≤T_{MAX}	**±0.18**		**±0.35**	**±0.15**		**±0.3**	˚C
Sensor Gain (Average Slope)	T_{MIN}≤T_A≤T_{MAX}	**+10.0**	**+9.9, +10.1**		**+10.0**		**+9.9, +10.1**	mV/˚C
Load Regulation (Note 3) 0≤I_L≤1 mA	T_A=+25˚C	±0.4	±1.0		±0.4	±1.0		mV/mA
	T_{MIN}≤T_A≤T_{MAX}	**±0.5**		**±3.0**	**±0.5**		**±3.0**	mV/mA
Line Regulation (Note 3)	T_A=+25˚C	±0.01	±0.05		±0.01	±0.05		mV/V
	4V≤V_S≤30V	**±0.02**		**±0.1**	**±0.02**		**±0.1**	mV/V
Quiescent Current (Note 9)	V_S=+5V, +25˚C	56	67		56	67		µA
	V_S=+5V	**105**		**131**	**91**		**114**	µA
	V_S=+30V, +25˚C	56.2	68		56.2	68		µA
	V_S=+30V	**105.5**		**133**	**91.5**		**116**	µA
Change of Quiescent Current (Note 3)	4V≤V_S≤30V, +25˚C	0.2	1.0		0.2	1.0		µA
	4V≤V_S≤30V	**0.5**		**2.0**	**0.5**		**2.0**	µA
Temperature Coefficient of Quiescent Current		**+0.39**		**+0.5**	**+0.39**		**+0.5**	µA/˚C
Minimum Temperature for Rated Accuracy	In circuit of *Figure 1*, I_L=0	+1.5		+2.0	+1.5		+2.0	˚C
Long Term Stability	T_J=T_{MAX}, for 1000 hours	±0.08			±0.08			˚C

Electrical Characteristics

(Notes 1, 6)

Parameter	Conditions	LM35			LM35C, LM35D			Units (Max.)
		Typical	Tested Limit (Note 4)	Design Limit (Note 5)	Typical	Tested Limit (Note 4)	Design Limit (Note 5)	
Accuracy,	T_A=+25˚C	±0.4	±1.0		±0.4	±1.0		˚C
LM35, LM35C	T_A=−10˚C	±0.5			±0.5		±1.5	˚C
(Note 7)	T_A=T_{MAX}	±0.8	±1.5		±0.8		±1.5	˚C
	T_A=T_{MIN}	±0.8		±1.5	±0.8		±2.0	˚C
Accuracy, LM35D	T_A=+25˚C				±0.6	±1.5		˚C
(Note 7)	T_A=T_{MAX}				±0.9		±2.0	˚C
	T_A=T_{MIN}				±0.9		±2.0	˚C
Nonlinearity	T_{MIN}≤T_A≤T_{MAX}	**±0.3**		**±0.5**	**±0.2**		**±0.5**	˚C
(Note 8)								
Sensor Gain	T_{MIN}≤T_A≤T_{MAX}	**+10.0**	**+9.8, +10.2**		**+10.0**		**+9.8, +10.2**	mV/˚C
(Average Slope)								
Load Regulation	T_A=+25˚C	±0.4	±2.0		±0.4	±2.0		mV/mA
(Note 3) 0≤I_L≤1 mA	T_{MIN}≤T_A≤T_{MAX}	**±0.5**		**±5.0**	**±0.5**		**±5.0**	mV/mA
Line Regulation	T_A=+25˚C	±0.01	±0.1		±0.01	±0.1		mV/V
(Note 3)	4V≤V_S≤30V	**±0.02**		**±0.2**	**±0.02**		**±0.2**	mV/V
Quiescent Current	V_S=+5V, +25˚C	56	80		56	80		µA
(Note 9)	V_S=+5V	**105**		**158**	**91**		**138**	µA
	V_S=+30V, +25˚C	56.2	82		56.2	82		µA
	V_S=+30V	**105.5**		**161**	**91.5**		**141**	µA
Change of	4V≤V_S≤30V, +25˚C	0.2	2.0		0.2	2.0		µA
Quiescent Current	4V≤V_S≤30V	**0.5**		**3.0**	**0.5**		**3.0**	µA
(Note 3)								
Temperature Coefficient of Quiescent Current		**+0.39**		**+0.7**	**+0.39**		**+0.7**	µA/˚C
Minimum Temperature for Rated Accuracy	In circuit of *Figure 1*, I_L=0	+1.5		+2.0	+1.5		+2.0	˚C
Long Term Stability	T_J=T_{MAX}, for 1000 hours	±0.08			±0.08			˚C

Note 1: Unless otherwise noted, these specifications apply: −55˚C≤T_J≤+150˚C for the LM35 and LM35A; −40˚C≤T_J≤+110˚C for the LM35C and LM35CA; and 0˚C≤T_J≤+100˚C for the LM35D. V_S=+5Vdc and I_{LOAD}=50 µA, in the circuit of *Figure 2*. These specifications also apply from +2˚C to T_{MAX} in the circuit of *Figure 1*. Specifications in **boldface** apply over the full rated temperature range.

Note 2: Thermal resistance of the TO-46 package is 400˚C/W, junction to ambient, and 24˚C/W junction to case. Thermal resistance of the TO-92 package is 180˚C/W junction to ambient. Thermal resistance of the small outline molded package is 220˚C/W junction to ambient. Thermal resistance of the TO-220 package is 90˚C/W junction to ambient. For additional thermal resistance information see table in the Applications section.

Note 3: Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output due to heating effects can be computed by multiplying the internal dissipation by the thermal resistance.

Note 4: Tested Limits are guaranteed and 100% tested in production.

Note 5: Design Limits are guaranteed (but not 100% production tested) over the indicated temperature and supply voltage ranges. These limits are not used to calculate outgoing quality levels.

Note 6: Specifications in **boldface** apply over the full rated temperature range.

Note 7: Accuracy is defined as the error between the output voltage and 10mv/˚C times the device's case temperature, at specified conditions of voltage, current, and temperature (expressed in ˚C).

Note 8: Nonlinearity is defined as the deviation of the output-voltage-versus-temperature curve from the best-fit straight line, over the device's rated temperature range.

Note 9: Quiescent current is defined in the circuit of *Figure 1*.

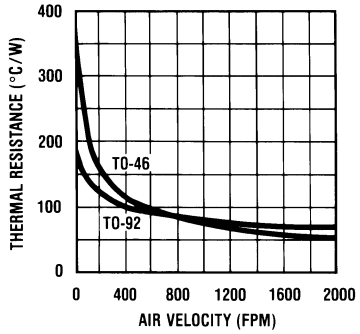
Note 10: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. DC and AC electrical specifications do not apply when operating the device beyond its rated operating conditions. See Note 1.

Note 11: Human body model, 100 pF discharged through a 1.5 kΩ resistor.

Note 12: See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" or the section titled "Surface Mount" found in a current National Semiconductor Linear Data Book for other methods of soldering surface mount devices.

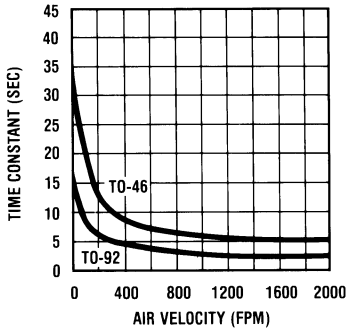
Typical Performance Characteristics

Thermal Resistance Junction to Air



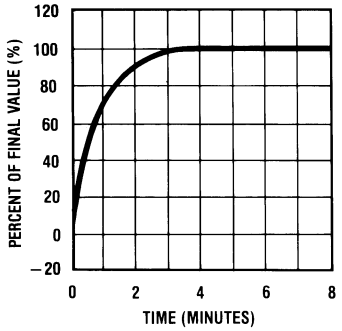
DS005516-25

Thermal Time Constant



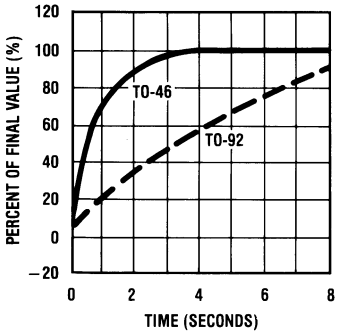
DS005516-26

Thermal Response in Still Air



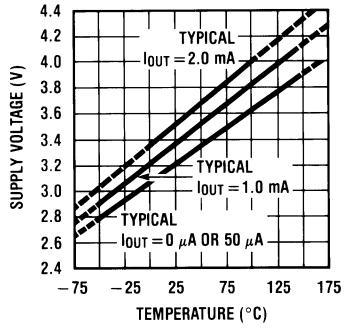
DS005516-27

Thermal Response in Stirred Oil Bath



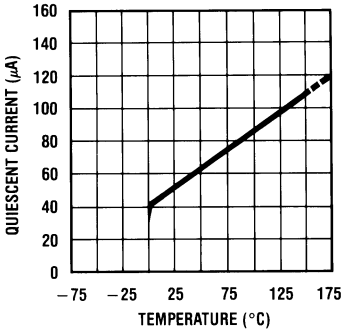
DS005516-28

Minimum Supply Voltage vs. Temperature



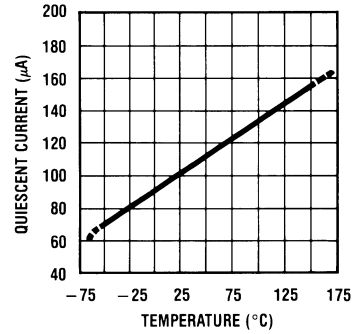
DS005516-29

Quiescent Current vs. Temperature (In Circuit of *Figure 1*.)



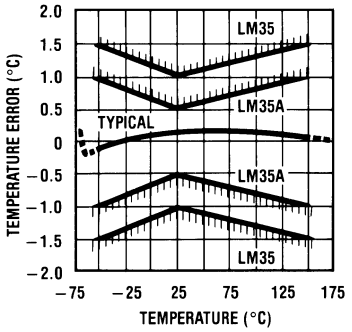
DS005516-30

Quiescent Current vs. Temperature (In Circuit of *Figure 2*.)



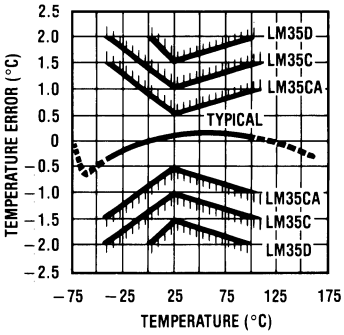
DS005516-31

Accuracy vs. Temperature (Guaranteed)



DS005516-32

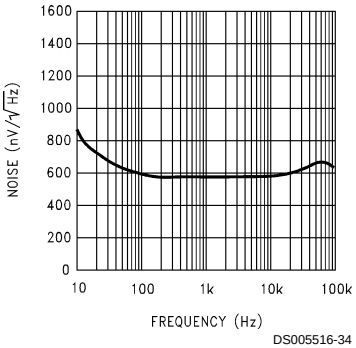
Accuracy vs. Temperature (Guaranteed)



DS005516-33

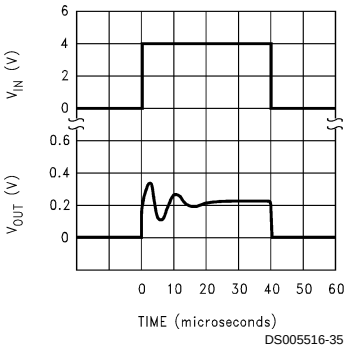
Typical Performance Characteristics (Continued)

Noise Voltage



DS005516-34

Start-Up Response



DS005516-35

Applications

The LM35 can be applied easily in the same way as other integrated-circuit temperature sensors. It can be glued or cemented to a surface and its temperature will be within about 0.01˚C of the surface temperature.

This presumes that the ambient air temperature is almost the same as the surface temperature; if the air temperature were much higher or lower than the surface temperature, the actual temperature of the LM35 die would be at an intermediate temperature between the surface temperature and the air temperature. This is expecially true for the TO-92 plastic package, where the copper leads are the principal thermal path to carry heat into the device, so its temperature might be closer to the air temperature than to the surface temperature.

To minimize this problem, be sure that the wiring to the LM35, as it leaves the device, is held at the same temperature as the surface of interest. The easiest way to do this is to cover up these wires with a bead of epoxy which will insure that the leads and wires are all at the same temperature as the surface, and that the LM35 die's temperature will not be affected by the air temperature.

The TO-46 metal package can also be soldered to a metal surface or pipe without damage. Of course, in that case the V− terminal of the circuit will be grounded to that metal. Alternatively, the LM35 can be mounted inside a sealed-end metal tube, and can then be dipped into a bath or screwed into a threaded hole in a tank. As with any IC, the LM35 and accompanying wiring and circuits must be kept insulated and dry, to avoid leakage and corrosion. This is especially true if the circuit may operate at cold temperatures where condensation can occur. Printed-circuit coatings and varnishes such as Humiseal and epoxy paints or dips are often used to insure that moisture cannot corrode the LM35 or its connections.

These devices are sometimes soldered to a small light-weight heat fin, to decrease the thermal time constant and speed up the response in slowly-moving air. On the other hand, a small thermal mass may be added to the sensor, to give the steadiest reading despite small deviations in the air temperature.

Temperature Rise of LM35 Due To Self-heating (Thermal Resistance, θ_{JA})

	TO-46, no heat sink	TO-46*, small heat fin	TO-92, no heat sink	TO-92**, small heat fin	SO-8 no heat sink	SO-8** small heat fin	TO-220 no heat sink
Still air	400˚C/W	100˚C/W	180˚C/W	140˚C/W	220˚C/W	110˚C/W	90˚C/W
Moving air	100˚C/W	40˚C/W	90˚C/W	70˚C/W	105˚C/W	90˚C/W	26˚C/W
Still oil	100˚C/W	40˚C/W	90˚C/W	70˚C/W			
Stirred oil	50˚C/W	30˚C/W	45˚C/W	40˚C/W			
(Clamped to metal, Infinite heat sink)	(24˚C/W)				(55˚C/W)		

*Wakefield type 201, or 1" disc of 0.020" sheet brass, soldered to case, or similar.
**TO-92 and SO-8 packages glued and leads soldered to 1" square of 1/16" printed circuit board with 2 oz. foil or similar.

Typical Applications

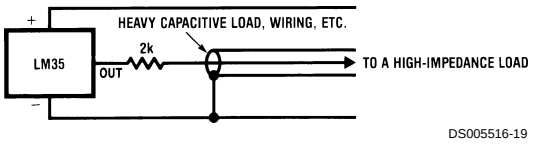


FIGURE 3. LM35 with Decoupling from Capacitive Load

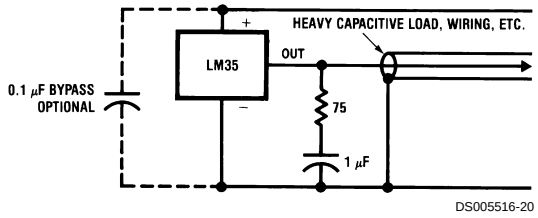


FIGURE 4. LM35 with R-C Damper

CAPACITIVE LOADS

Like most micropower circuits, the LM35 has a limited ability to drive heavy capacitive loads. The LM35 by itself is able to drive 50 pf without special precautions. If heavier loads are anticipated, it is easy to isolate or decouple the load with a resistor; see *Figure 3*. Or you can improve the tolerance of capacitance with a series R-C damper from output to ground; see *Figure 4*.

When the LM35 is applied with a 200Ω load resistor as shown in *Figure 5*, *Figure 6* or *Figure 8* it is relatively immune to wiring capacitance because the capacitance forms a bypass from ground to input, not on the output. However, as with any linear circuit connected to wires in a hostile environment, its performance can be affected adversely by intense electromagnetic sources such as relays, radio transmitters, motors with arcing brushes, SCR transients, etc, as its wiring can act as a receiving antenna and its internal junctions can act as rectifiers. For best results in such cases, a bypass capacitor from V_{IN} to ground and a series R-C damper such as 75Ω in series with 0.2 or 1 µF from output to ground are often useful. These are shown in *Figure 13*, *Figure 14*, and *Figure 16*.

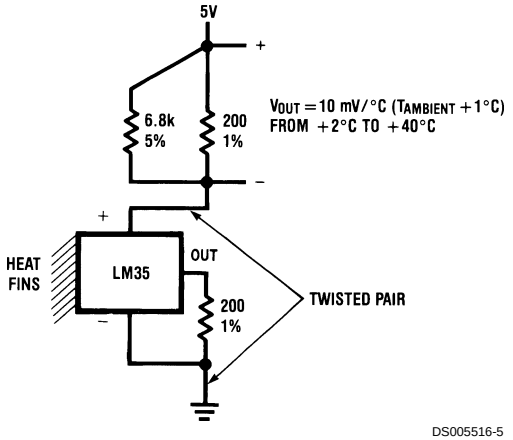


FIGURE 5. Two-Wire Remote Temperature Sensor (Grounded Sensor)

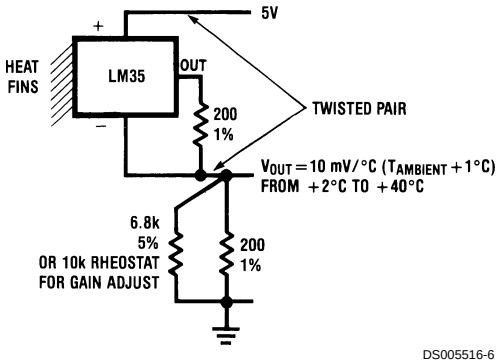


FIGURE 6. Two-Wire Remote Temperature Sensor (Output Referred to Ground)

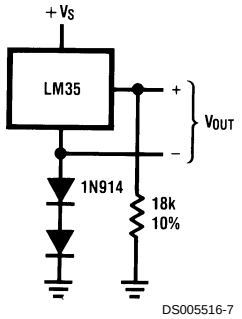


FIGURE 7. Temperature Sensor, Single Supply, −55˚ to +150˚C

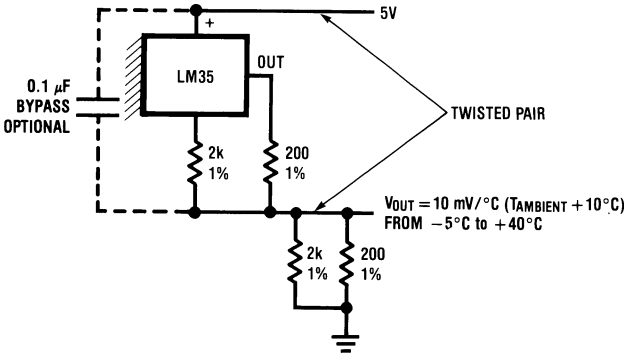


FIGURE 8. Two-Wire Remote Temperature Sensor (Output Referred to Ground)

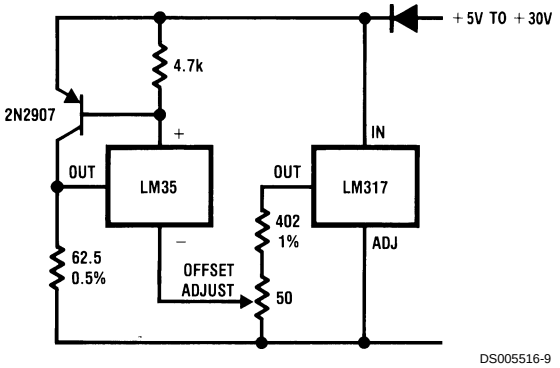


FIGURE 9. 4-To-20 mA Current Source (0˚C to +100˚C)

Typical Applications (Continued)

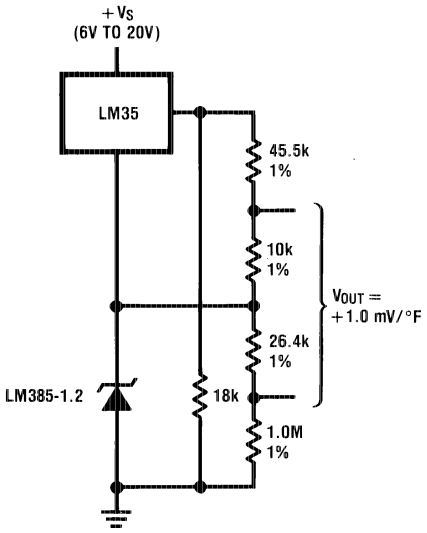


FIGURE 10. Fahrenheit Thermometer

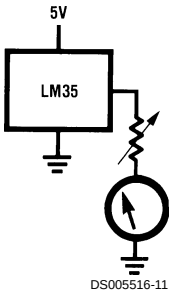


FIGURE 11. Centigrade Thermometer (Analog Meter)

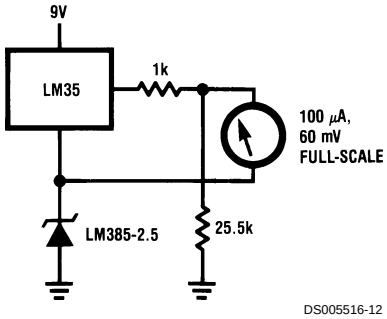


FIGURE 12. Fahrenheit ThermometerExpanded Scale Thermometer
(50˚ to 80˚ Fahrenheit, for Example Shown)

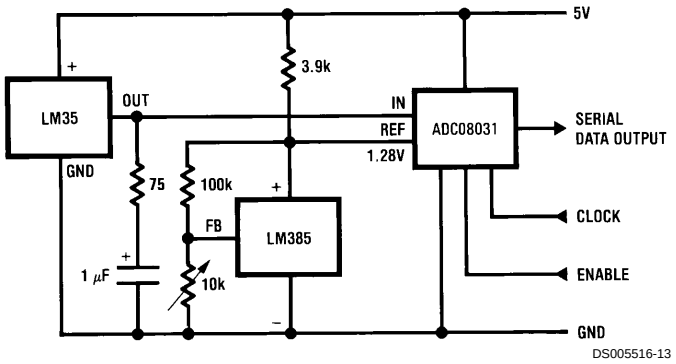


FIGURE 13. Temperature To Digital Converter (Serial Output) (+128˚C Full Scale)

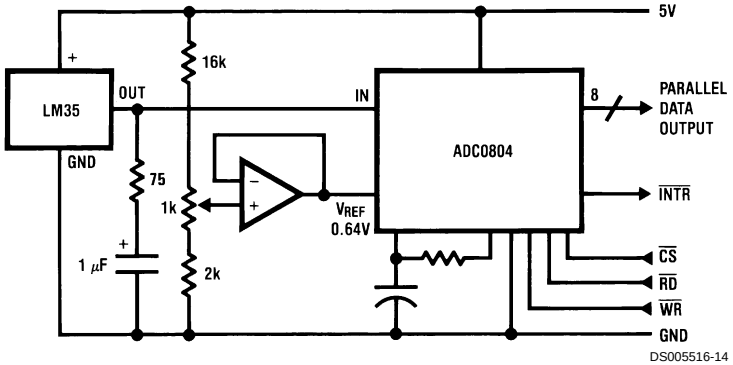
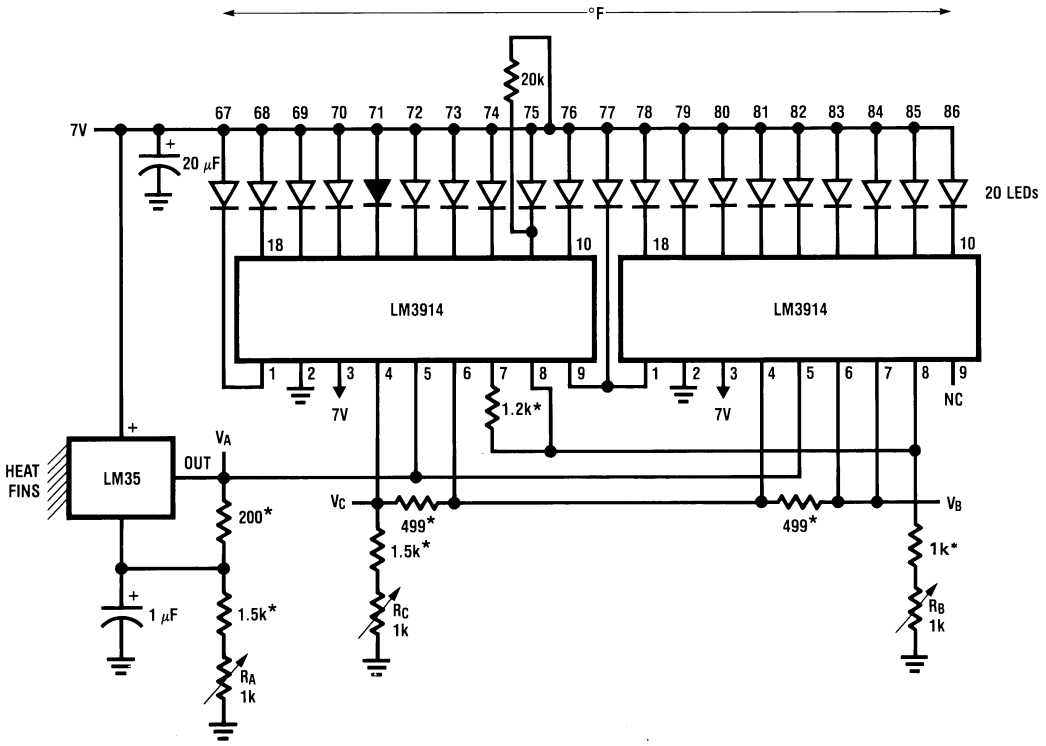


FIGURE 14. Temperature To Digital Converter (Parallel TRI-STATE™ Outputs for Standard Data Bus to µP Interface) (128˚C Full Scale)

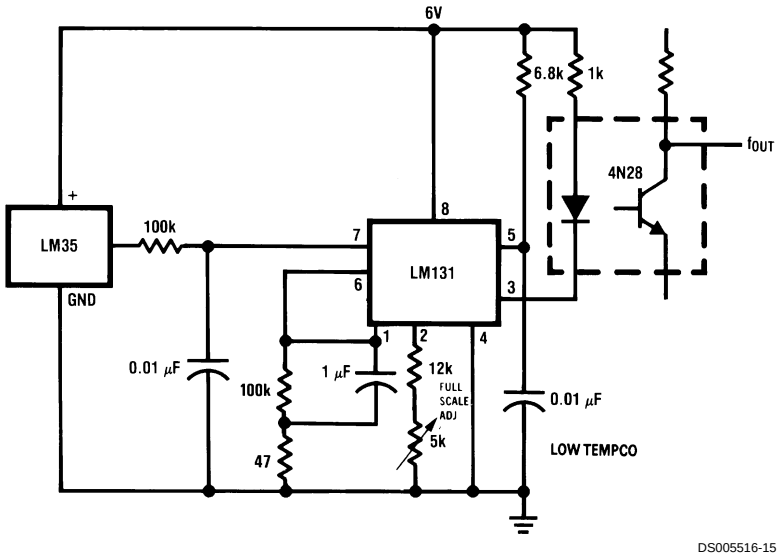
Typical Applications (Continued)



DS005516-16

*=1% or 2% film resistor
Trim R_B for V_B=3.075V
Trim R_C for V_C=1.955V
Trim R_A for V_A=0.075V + 100mV/°C x $T_{ambient}$
Example, V_A=2.275V at 22°C

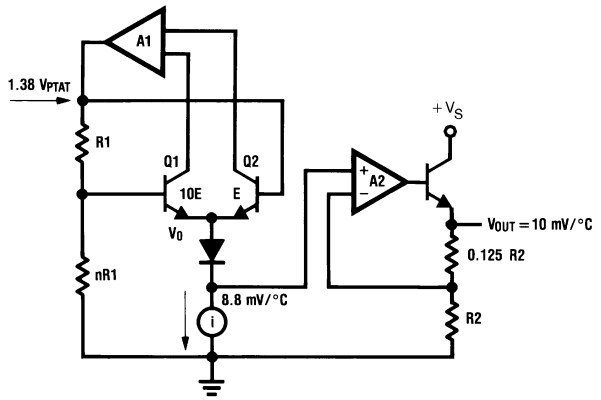
FIGURE 15. Bar-Graph Temperature Display (Dot Mode)



DS005516-15

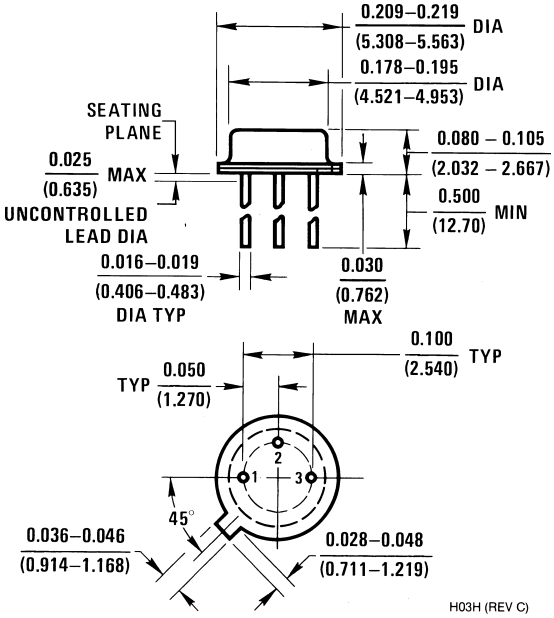
FIGURE 16. LM35 With Voltage-To-Frequency Converter And Isolated Output (2°C to +150°C; 20 Hz to 1500 Hz)

Block Diagram

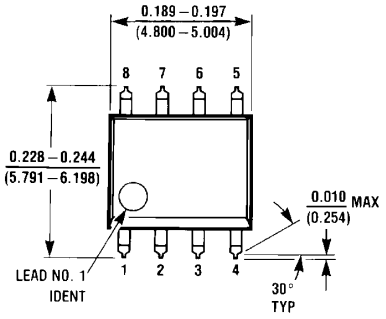


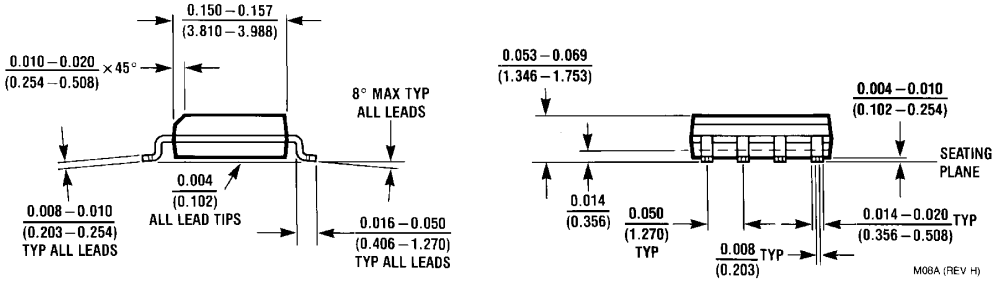
DS005516-23

Physical Dimensions inches (millimeters) unless otherwise noted



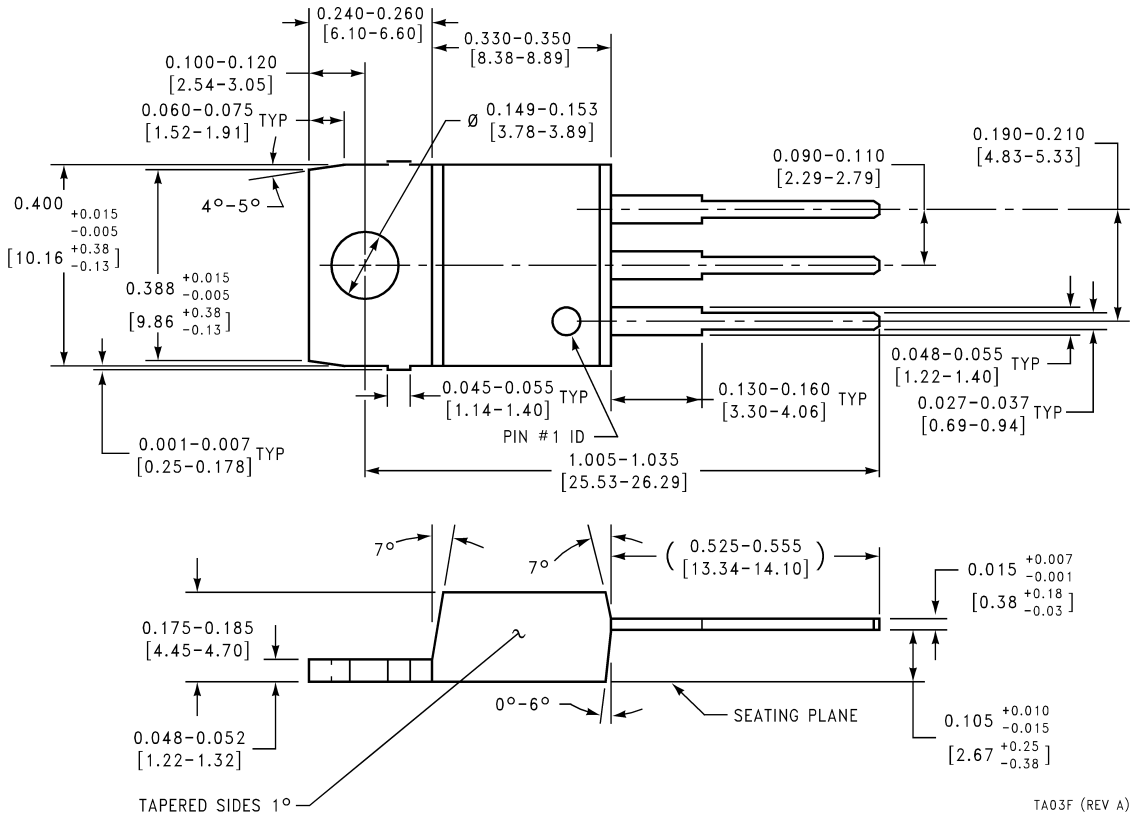
TO-46 Metal Can Package (H)
Order Number LM35H, LM35AH, LM35CH, LM35CAH, or LM35DH
NS Package Number H03H



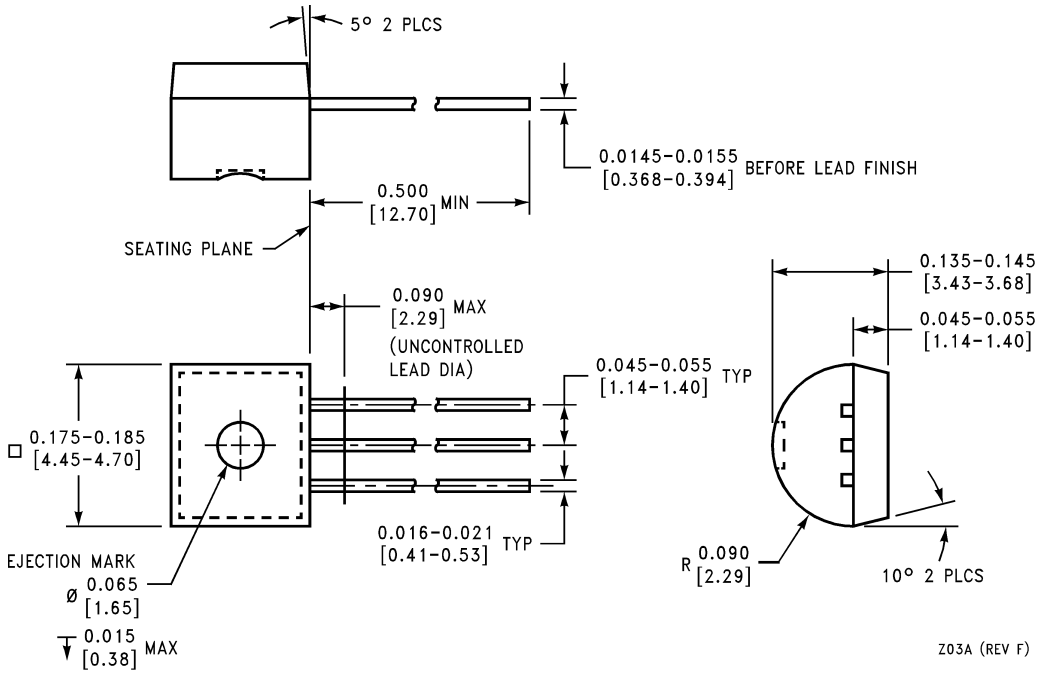


SO-8 Molded Small Outline Package (M)
Order Number LM35DM
NS Package Number M08A

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



Power Package TO-220 (T)
Order Number LM35DT
NS Package Number TA03F



TO-92 Plastic Package (Z)
Order Number LM35CZ, LM35CAZ or LM35DZ
NS Package Number Z03A

Notes

LIFE SUPPORT POLICY

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Low Cost, Miniature Fiber Optic Components with ST®, SMA, SC and FC Ports

Technical Data

HFBR-0400 Series

Features

- **Meets IEEE 802.3 Ethernet and 802.5 Token Ring Standards**
- **Low Cost Transmitters and Receivers**
- **Choice of ST®, SMA, SC or FC Ports**
- **820 nm Wavelength Technology**
- **Signal Rates up to 175 Megabaud**
- **Link Distances Up to 4 km**
- **Specified with 50/125 μm, 62.5/125 μm, 100/140 μm, and 200 μm HCS® Fiber**
- **Repeatable ST Connections within 0.2 dB Typical**
- **Unique Optical Port Design for Efficient Coupling**
- **Auto-Insertable and Wave Solderable**
- **No Board Mounting Hardware Required**
- **Wide Operating Temperature Range -40°C to 85°C**
- **AlGaAs Emitters 100% Burn-In Ensures High Reliability**
- **Conductive Port Option with the SMA and ST Threaded Port Styles**

Applications

- **Local Area Networks**
- **Computer to Peripheral Links**
- **Computer Monitor Links**
- **Digital Cross Connect Links**
- **Central Office Switch/PBX Links**
- **Video Links**
- **Modems and Multiplexers**
- **Suitable for Tempest Systems**
- **Industrial Control Links**

Description

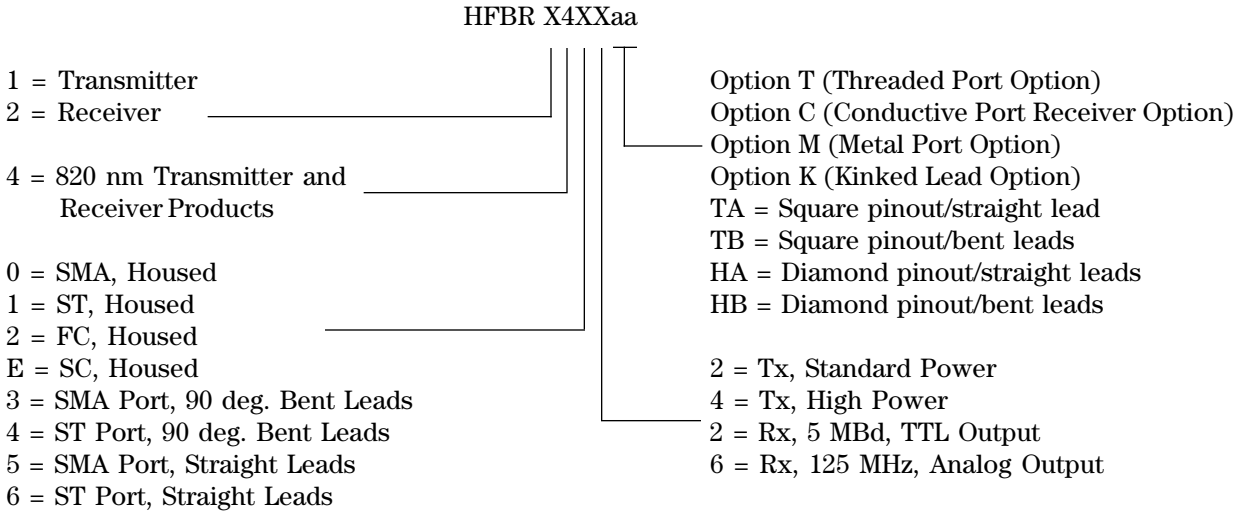
The HFBR-0400 Series of components is designed to provide cost effective, high performance fiber optic communication links for information systems and industrial applications with link distances of up to 4 kilometers. With the HFBR-24X6, the 125 MHz analog receiver, data rates of up to 175 megabaud are attainable.

Transmitters and receivers are directly compatible with popular "industry-standard" connectors: ST, SMA, SC and FC. They are completely specified with multiple fiber sizes; including 50/125 μm, 62.5/125 μm, 100/140 μm, and 200 μm.

Complete evaluation kits are available for ST and SMA product offerings; including transmitter, receiver, connectored cable, and technical literature. In addition, ST and SMA connectored cables are available for evaluation.

ST® is a registered trademark of AT&T.
HCS® is a registered trademark of the SpecTran Corporation.

HFBR-0400 Series Part Number Guide


HFBR X4XXaa
1 = Transmitter
2 = Receiver
4 = 820 nm Transmitter and Receiver Products
0 = SMA, Housed
1 = ST, Housed
2 = FC, Housed
E = SC, Housed
3 = SMA Port, 90 deg. Bent Leads
4 = ST Port, 90 deg. Bent Leads
5 = SMA Port, Straight Leads
6 = ST Port, Straight Leads
Option T (Threaded Port Option)
Option C (Conductive Port Receiver Option)
Option M (Metal Port Option)
Option K (Kinked Lead Option)
TA = Square pinout/straight lead
TB = Square pinout/bent leads
HA = Diamond pinout/straight leads
HB = Diamond pinout/bent leads
2 = Tx, Standard Power
4 = Tx, High Power
2 = Rx, 5 MBd, TTL Output
6 = Rx, 125 MHz, Analog Output

LINK SELECTION GUIDE

Data Rate (MBd)	Distance (m)	Transmitter	Receiver	Fiber Size (μm)	Evaluation Kit
5	1500	HFBR-14X2	HFBR-24X2	200 HCS	N/A
5	2000	HFBR-14X4	HFBR-24X2	62.5/125	HFBR-04X0
20	2700	HFBR-14X4	HFBR-24X6	62.5/125	HFBR-0414, HFBR-0463
32	2200	HFBR-14X4	HFBR-24X6	62.5/125	HFBR-0414
55	1400	HFBR-14X4	HFBR-24X6	62.5/125	HFBR-0414
125	700	HFBR-14X4	HFBR-24X6	62.5/125	HFBR-0416
155	600	HFBR-14X4	HFBR-24X6	62.5/125	HFBR-0416
175	500	HFBR-14X4	HFBR-24X6	62.5/125	HFBR-0416

For additional information on specific links see the following individual link descriptions. Distances measured over temperature range from 0 to 70°C.

Applications Support Guide

This section gives the designer information necessary to use the HFBR-0400 series components to make a functional fiber-optic transceiver. HP offers a wide selection of evaluation kits for hands-on experience with fiber-optic products as well as a wide range of application notes complete with circuit diagrams and board layouts. Furthermore, HP's application support group is always ready to assist with any design consideration.

Application Literature

Title	Description
HFBR-0400 Series Reliability Data	Transmitter & Receiver Reliability Data
Application Bulletin 73	Low Cost Fiber Optic Transmitter & Receiver Interface Circuits
Application Bulletin 78	Low Cost Fiber Optic Links for Digital Applications up to 155 MBd
Application Note 1038	Complete Fiber Solutions for IEEE 802.3 FOIRL, 10Base-FB and 10 Base-FL
Application Note 1065	Complete Solutions for IEEE 802.5J Fiber-Optic Token Ring
Application Note 1073	HFBR-0319 Test Fixture for 1X9 Fiber Optic Transceivers
Application Note 1086	Optical Fiber Interconnections in Telecommunication Products

Contact your local HP components sales office to obtain these publications or download directly from the World Wide Web @ http: //www.hp.com/go/fiber/

HFBR-0400 Series Evaluation Kits

HFBR-0410 ST Evaluation Kit

Contains the following :

- One HFBR-1412 transmitter
- One HFBR-2412 five megabaud TTL receiver
- Three meters of ST connectored 62.5/125 (µm fiber optic cable with low cost plastic ferrules.
- Related literature

HFBR-0414 ST Evaluation Kit

Includes additional components to interface to the transmitter and receiver as well as the PCB to reduce design time.

Contains the following:

- One HFBR-1414T transmitter
- One HFBR-2416T receiver
- Three meters of ST connectored 62.5/125 µm fiber optic cable
- Printed circuit board
- ML-4622 CP Data Quantizer
- 74ACTllOOON LED Driver
- LT1016CN8 Comparator
- 4.7 µH Inductor
- Related literature

HFBR-0400 SMA Evaluation Kit

Contains the following :

- One HFBR-1402 transmitter
- One HFBR-2402 five megabaud TTL receiver
- Two meters of SMA connectored 1000 µm plastic optical fiber
- Related literature

HFBR-0416 Evaluation Kit

Contains the following:

- One fully assembled 1x9 transceiver board for 155 MBd evaluation including:
  -HFBR-1414 transmitter
  -HFBR-2416 receiver
  -circuitry
- Related literature

HFBR-0463 Ethernet MAU Evaluation Kit

Contains the following:

- One fully assembled Media Attachment Unit (MAU) board which includes:
  -HFBR-1414 transmitter
  -HFBR-2416 receiver
  -HFBR-4663 IC
- Related literature

Note: Cable not included. Order HFBR-BXS010 seperately (2 pieces)

Package and Handling Information

Package Information

All HFBR-0400 Series transmitters and receivers are housed in a low-cost, dual-inline package that is made of high strength, heat resistant, chemically resistant, and UL 94V-O flame retardant ULTEM® (plastic (UL File #E121562). The transmitters are easily identified by the light grey color connector port. The receivers are easily identified by the dark grey color connector port. (Black color for conductive port.) The package is designed for auto-insertion and wave soldering so it is ideal for high volume production applications.

Handling and Design Information

Each part comes with a protective port cap or plug covering the optics. These caps/plugs will vary by port style. When soldering, it is advisable to leave the protective cap on the unit to keep the optics clean. Good system performance requires clean port optics and cable ferrules to avoid obstructing the optical path. Clean compressed air often is sufficient to remove particles of dirt; methanol on a cotton swab also works well.

Recommended Chemicals for Cleaning/Degreasing HFBR-0400 Products

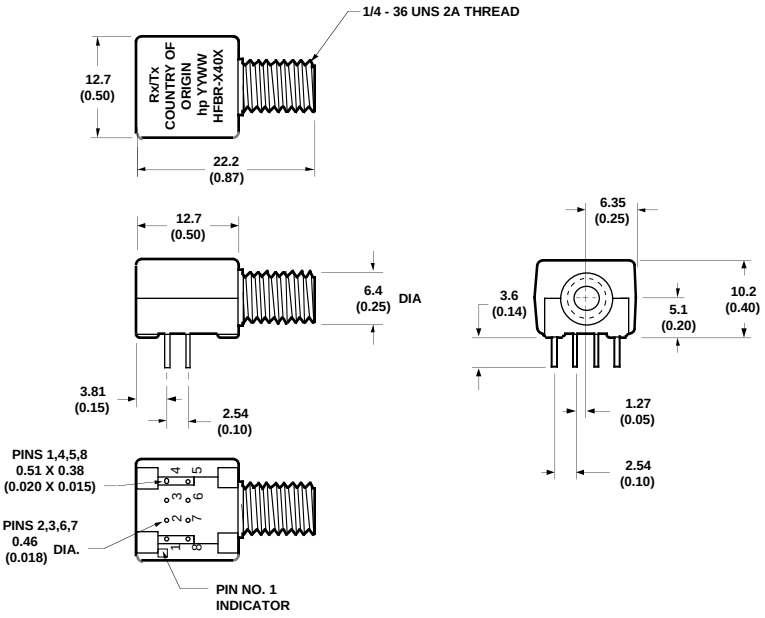
Alcohols: methyl, isopropyl, isobutyl. Aliphatics: hexane, heptane, Other: soap solution, naphtha.

Do not use partially halogenated hydrocarbons such as 1,1.1 trichloroethane, ketones such as MEK, acetone, chloroform, ethyl acetate, methylene dichloride, phenol, methylene chloride, or N-methylpyrolldone. Also, HP does not recommend the use of cleaners that use halogenated hydrocarbons because of their potential environmental harm.

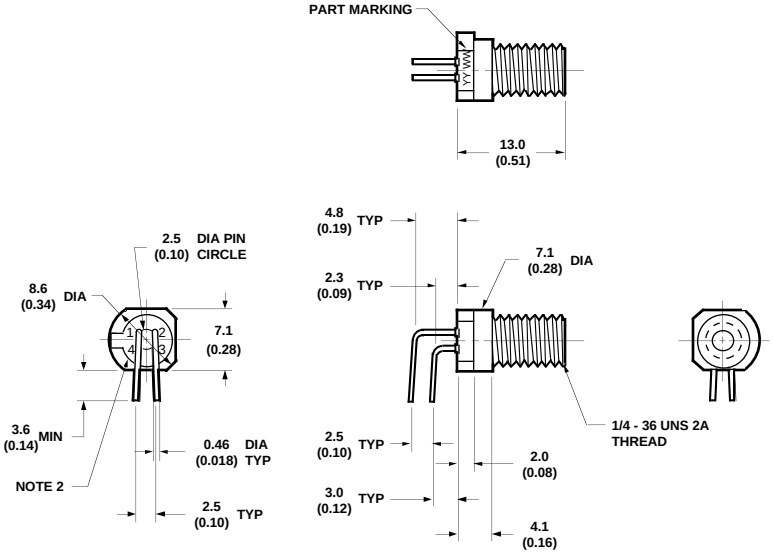
Ultem® is a registered Trademark of the GE corporation.

Mechanical Dimensions HFBR-0400 SMA Series

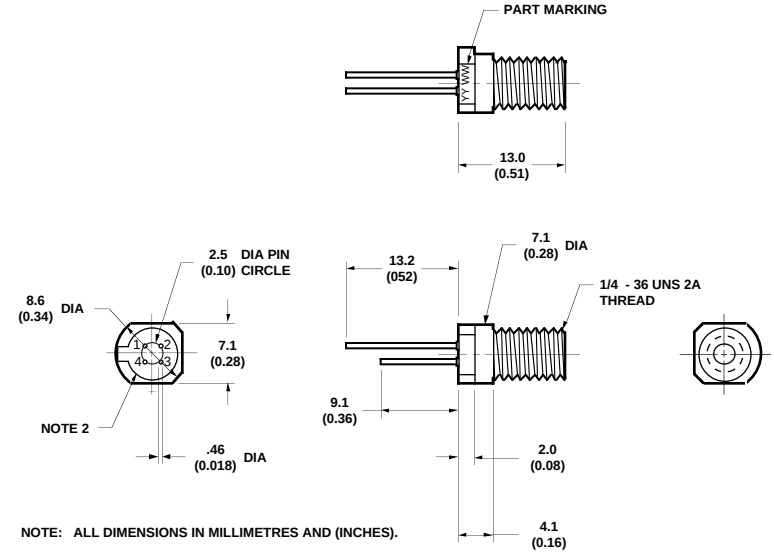
HFBR-X40X



HFBR-X43X



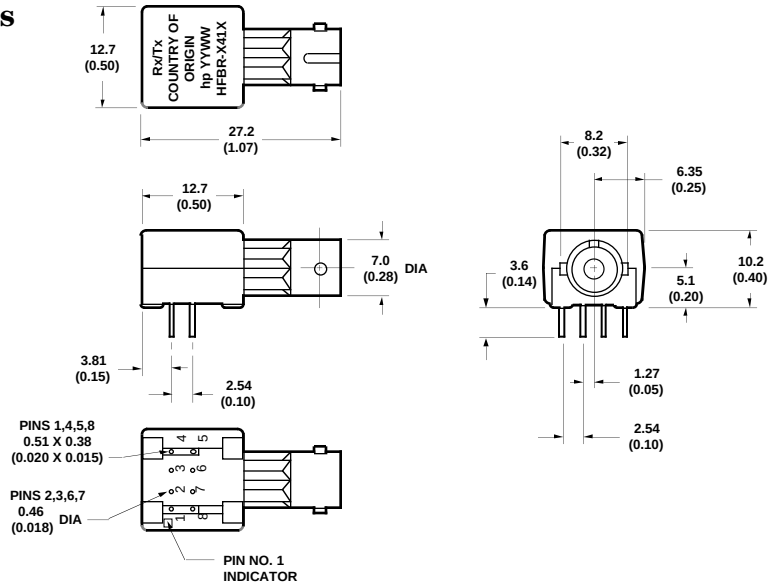
HFBR-X45X



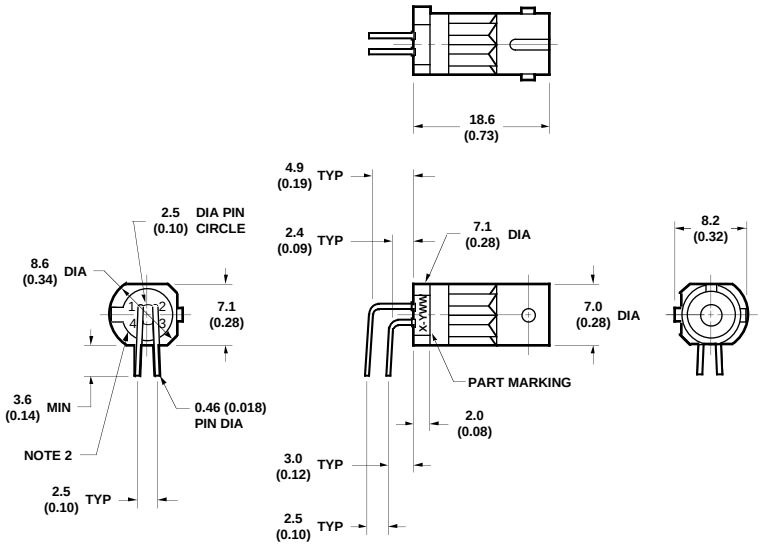
NOTE: ALL DIMENSIONS IN MILLIMETRES AND (INCHES).

Mechanical Dimensions
HFBR-0400 ST Series

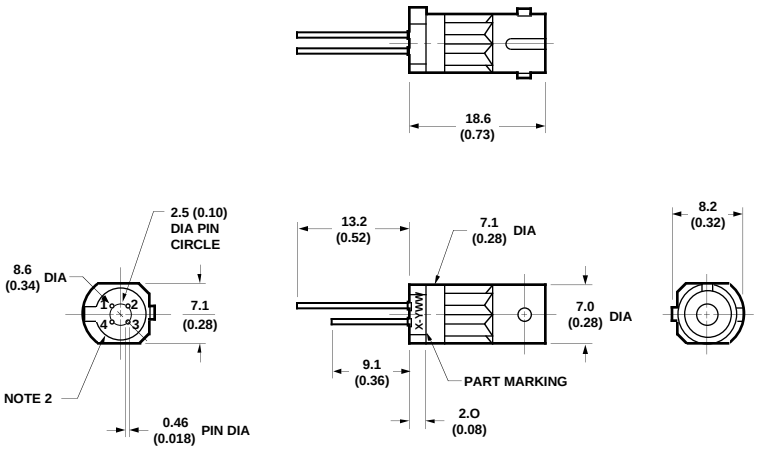
HFBR-X41X



HFBR-X44X



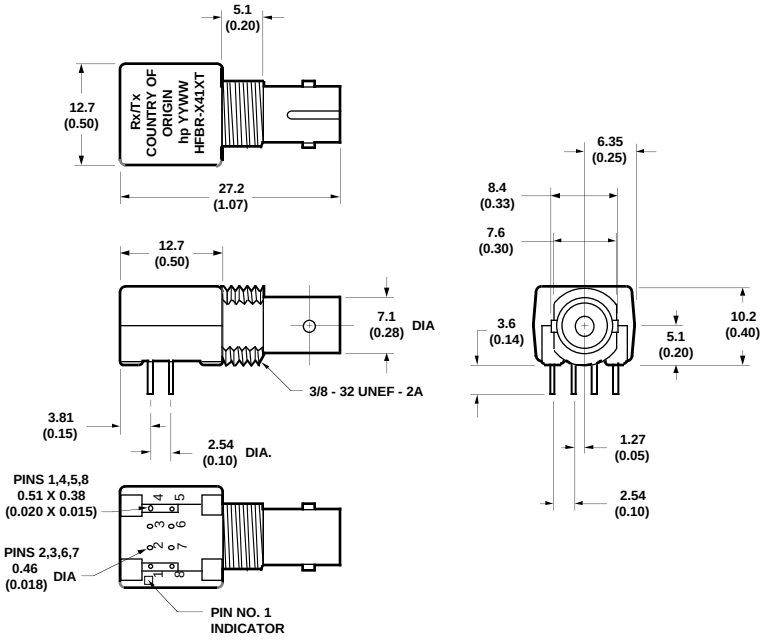
HFBR-X46X



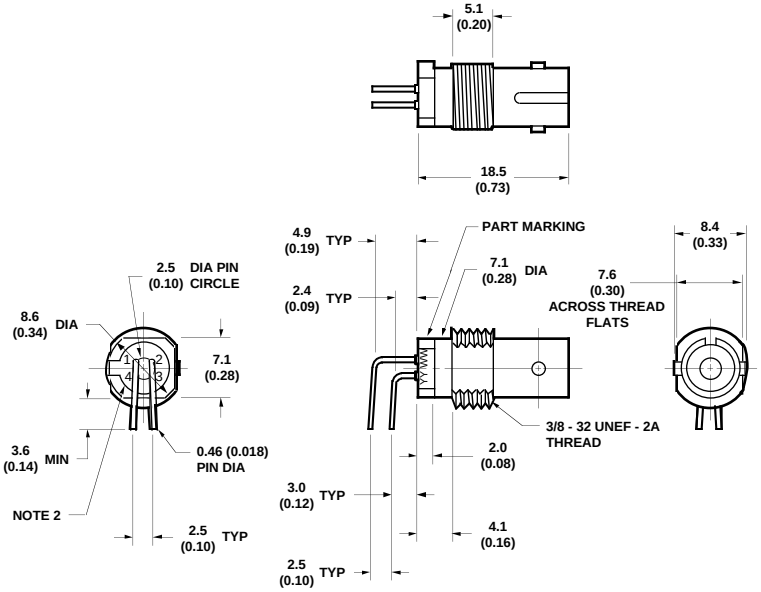
NOTE: ALL DIMENSIONS IN MILLIMETRES AND (INCHES).

Mechanical Dimensions HFBR-0400T Threaded ST Series

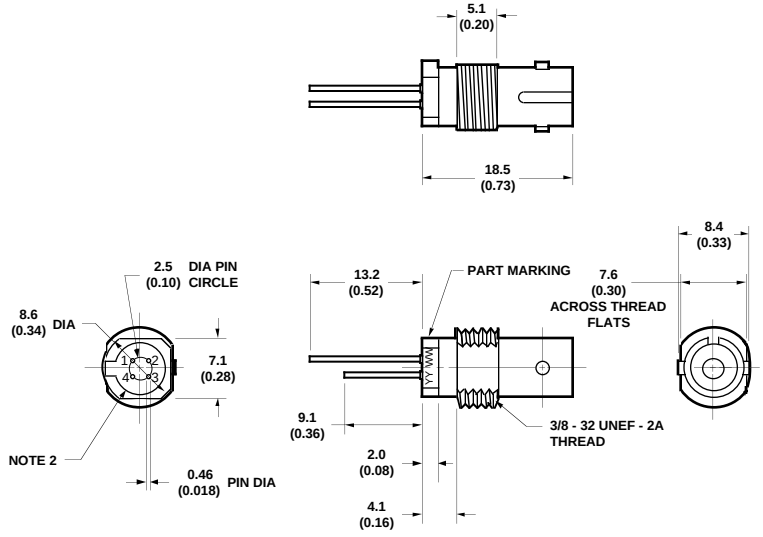
HFBR-X41XT



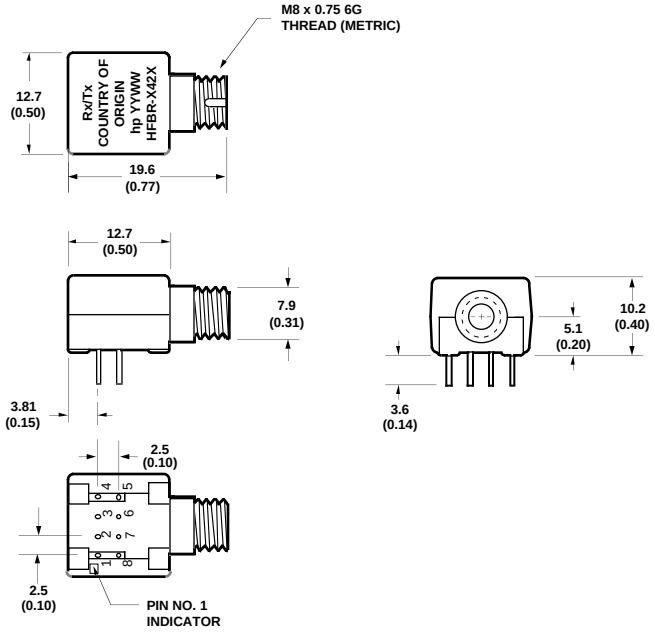
HFBR-X44XT



HFBR-X46XT

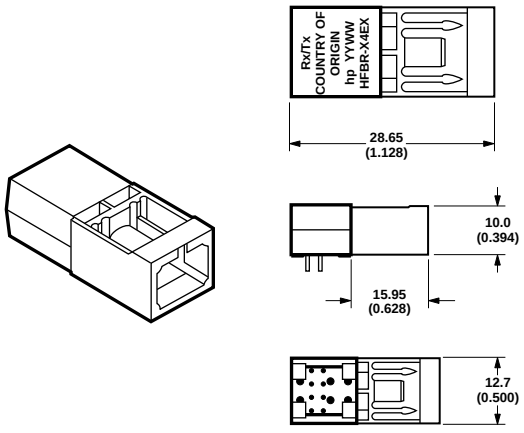


Mechanical Dimensions
HFBR-0400FC Series



Mechanical Dimensions
HFBR-0400 SC Series

HFBR-X4EX



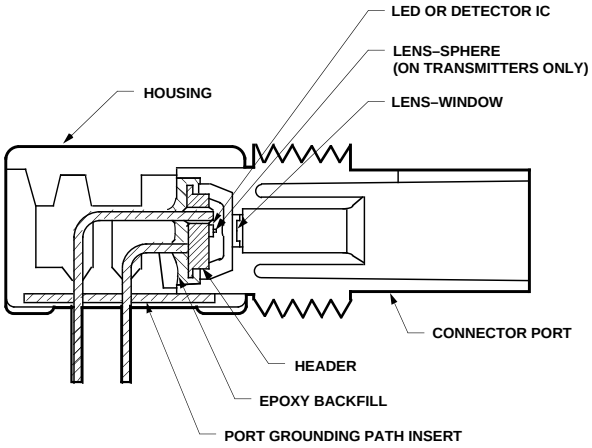
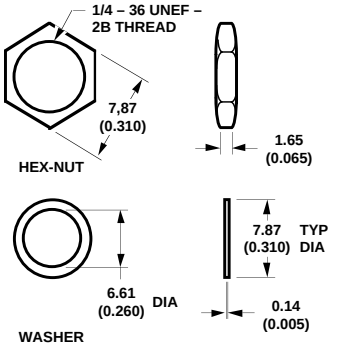


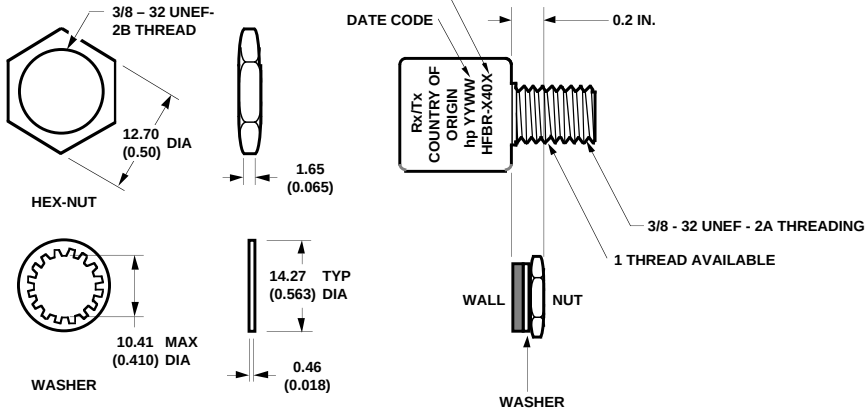
Figure 1. HFBR-0400 ST Series Cross-Sectional View.

Panel Mount Hardware

HFBR-4401: for SMA Ports



HFBR-4411: for ST Ports



(Each HFBR-4401 and HFBR-4411 kit consists of 100 nuts and 100 washers.)

Port Cap Hardware

HFBR-4402: 500 SMA Port Caps
HFBR-4120: 500 ST Port Plugs (120 psi)
HFBR-4412: 500 FC Port Caps
HFBR-4417: 500 SC Port Plugs

Options

In addition to the various port styles available for the HFBR-0400 series products, there are also several extra options that can be ordered. To order an option, simply place the corresponding option number at the end of the part number. For instance, a metal-port option SMA receiver would be HFBR-2406M. You can add any number of options in series at the end of a part number. Please contact your local sales office for further information or browse HP's fiber optics home page at http://www.hp.com/go/fiber/

Option T (Threaded Port Option)

- Allows ST style port components to be panel mounted.
- Compatible with all current makes of ST multimode connectors
- Mechanical dimensions are compliant with MIL-STD-83522/13
- Maximum wall thickness when using nuts and washers from the HFBR-4411 hardware kit is 2.8 mm (0.11 inch)
- Available on all ST ports

Option C (Conductive Port Receiver Option)

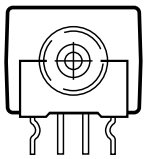
- Designed to withstand electrostatic discharge (ESD) of 25kV to the port
- Significantly reduces effect of electromagnetic interference (EMI) on receiver sensitivity
- Allows designer to separate the signal and conductive port grounds
- Recommended for use in noisy environments
- Available on SMA and threaded ST port style receivers only

Option M (Metal Port Option)

- Nickel plated aluminum connector receptacle
- Designed to withstand electrostatic discharge (ESD) of 15kV to the port
- Significantly reduces effect of electromagnetic interference (EMI) on receiver sensitivity
- Allows designer to separate the signal and metal port grounds
- Recommended for use in very noisy environments
- Available on SMA, FC, ST, and threaded ST ports

Option K (Kinked Lead Option)

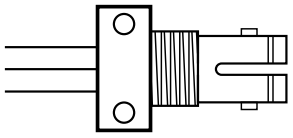
- Grounded outside 4 leads are "kinked"
- Allows components to stay anchored in the PCB during wave solder and aqueous wash processes



Options TA, TB, HA, HB (Active Device Mount Options)

(These options are unrelated to the threaded port option T.)

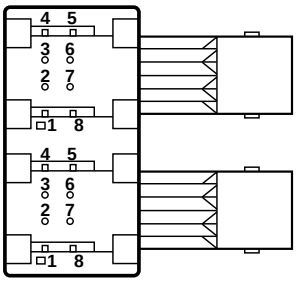
- All metal, panel mountable package with a 3 or 4 pin receptacle end
- Available for HFBR-14X4, 24X2 and 24X6 components
- Choose from diamond or square pinout, straight or bent leads ADM Picture



- TA = Square pinout/straight leads
  TB = Square pinout/bent leads
  HA = Diamond pinout/straight leads
  HB = Diamond pinout/bent leads

Duplex Option

In addition to the standard options, some HFBR-0400 series products come in a duplex configuration with the transmitter on the left and the receiver on the right. This option was designed for ergonomic and efficient manufacturing. The following part numbers are available in the duplex option:
HFBR-5414 (Duplex ST)
HFBR-5414T (Duplex Threaded ST)
HFBR-54E4 (Duplex SC)



Typical Link Data

HFBR-0400 Series

Description

The following technical data is taken from 4 popular links using the HFBR-0400 series: the 5 MBd link, Ethernet 20 MBd link, Token Ring 32 MBd link, and the 155 MBd link. The data given corresponds to transceiver solutions combining the HFBR-0400 series components and various recommended transceiver design circuits using off-the-shelf electrical components. This data is meant to be regarded as an example of typical link performance for a given design and does not call out any link limitations. Please refer to the appropriate application note given for each link to obtain more information.

5 MBd Link (HFBR-14XX/24X2)

Link Performance -40°C to +85°C unless otherwise specified

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions	Reference
Optical Power Budget with 50/125 µm fiber	OPB_{50}	4.2	9.6		dB	HFBR-14X4/24X2 NA = 0.2	Note 1
Optical Power Budget with 62.5/125 µm fiber	$OPB_{62.5}$	8.0	15		dB	HFBR-14X4/24X2 NA = 0.27	Note 1
Optical Power Budget with 100/140 µm fiber	OPB_{100}	8.0	15		dB	HFBR-14X2/24X2 NA = 0.30	Note 1
Optical Power Budget with 200 µm fiber	OPB_{200}	12	20		dB	HFBR-14X2/24X2 NA = 0.37	Note 1
Date Rate Synchronous		dc		5	MBd		Note 2
Asynchronous		dc		2.5	MBd		Note 3, Fig. 7
Propagation Delay LOW to HIGH	t_{PLH}		72		ns	T_A = 25°C, P_R = -21 dBm Peak	Figs. 6, 7, 8
Propagation Delay HIGH to LOW	t_{PHL}		46		ns		
System Pulse Width Distortion	t_{PLH}-t_{PHL}		26		ns	Fiber cable length = 1 m	
Bit Error Rate	BER			10^{-9}		Data Rate <5 Bd P_R > -24 dBm Peak	

Notes:

1. OPB at T_A = -40 to 85°C, V_{CC} = 5.0 V dc, $I_{F\ ON}$ = 60 mA. P_R = -24 dBm peak.
2. Synchronous data rate limit is based on these assumptions: a) 50% duty factor modulation, e.g., Manchester I or BiPhase Manchester II; b) continuous data; c) PLL Phase Lock Loop demodulation; d) TTL threshold.
3. Asynchronous data rate limit is based on these assumptions: a) NRZ data; b) arbitrary timing-no duty factor restriction; c) TTL threshold.

5 MBd Logic Link Design

If resistor R_1 in Figure 2 is 70.4 Ω, a forward current I_F of 48 mA is applied to the HFBR-14X4 LED transmitter. With I_F = 48 mA the HFBR-14X4/24X2 logic link is guaranteed to work with 62.5/125 µm fiber optic cable over the entire range of 0 to 1750 meters at a data rate of dc to 5 MBd, with arbitrary data format and pulse width distortion typically less than 25%. By setting R_1 = 115 Ω, the transmitter can be driven with I_F = 30 mA, if it is desired to economize on power or achieve lower pulse distortion.

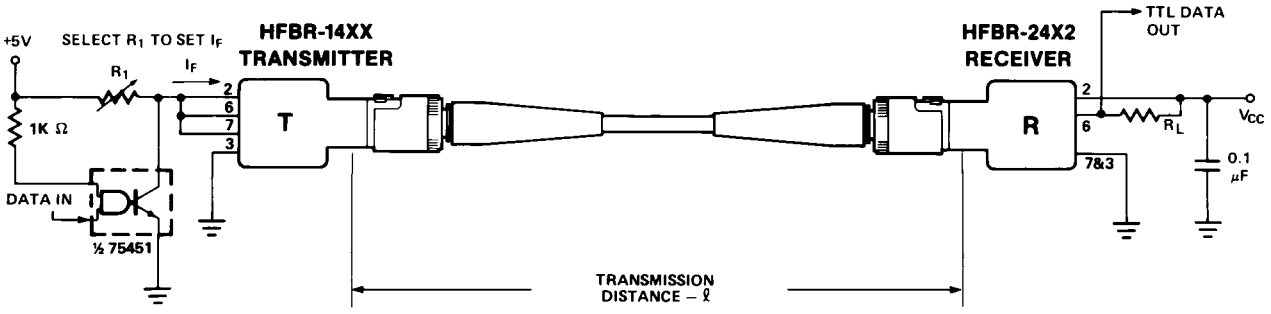
The following example will illustrate the technique for selecting the appropriate value of I_F and R_1.

Maximum distance required = 400 meters. From Figure 3 the drive current should be 15 mA. From the transmitter data V_F = 1.5 V (max.) at I_F = 15 mA as shown in Figure 9.

$$R_1 = \frac{V_{CC} - V_F}{I_F} = \frac{5\text{ V} - 1.5\text{ V}}{15\text{ mA}}$$

$$R_1 = 233\ \Omega$$

The curves in Figures 3, 4, and 5 are constructed assuming no in-line splice or any additional system loss. Should the link consists of any in-line splices, these curves can still be used to calculate link limits provided they are shifted by the additional system loss expressed in dB. For example, Figure 3 indicates that with 48 mA of transmitter drive current, a 1.75 km link distance is achievable with 62.5/125 µm fiber which has a maximum attenuation of 4 dB/km. With 2 dB of additional system loss, a 1.25 km link distance is still achievable.



NOTE:
IT IS ESSENTIAL THAT A BYPASS CAPACITOR (0.01 µF TO 0.1 µF CERAMIC) BE CONNECTED FROM PIN 2 TO PIN 7 OF THE RECEIVER. TOTAL LEAD LENGTH BETWEEN BOTH ENDS OF THE CAPACITOR AND THE PINS SHOULD NOT EXCEED 20 mm.

Figure 2. Typical Circuit Configuration.

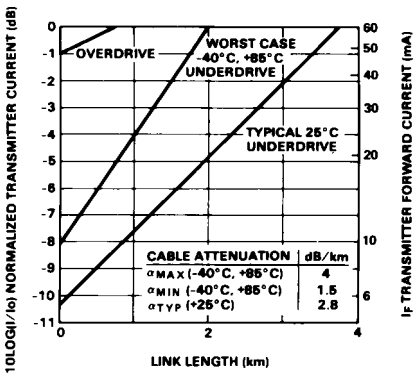


Figure 3. HFBR-1414/HFBR-2412 Link Design Limits with 62.5/125 µm Cable.

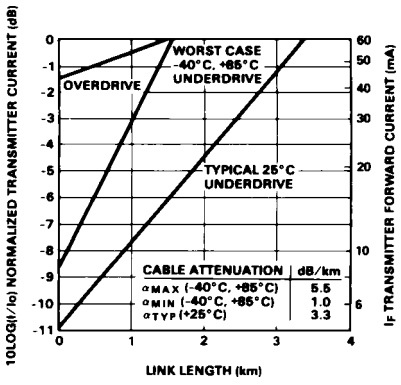


Figure 4. HFBR-14X2/HFBR-24X2 Link Design Limits with 100/140 µm Cable.

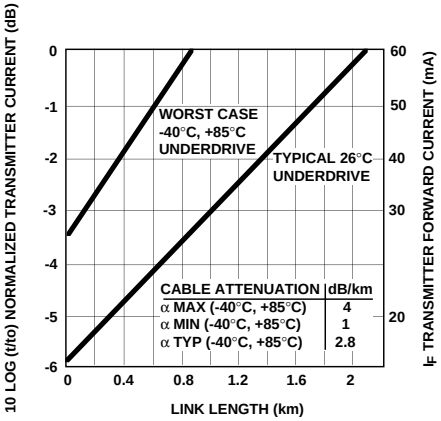


Figure 5. HFBR-14X4/HFBR-24X2 Link Design Limits with 50/125 µm Cable.

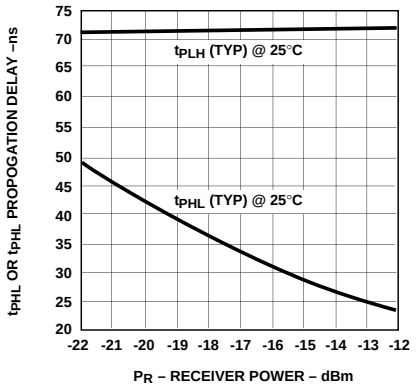


Figure 6. Propagation Delay through System with One Meter of Cable.

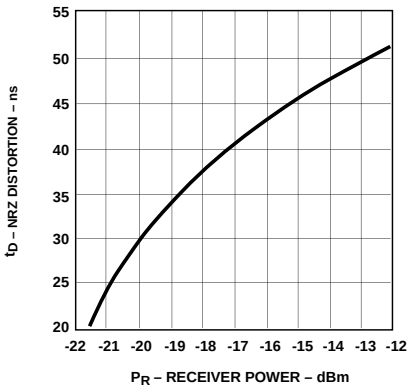


Figure 7. Typical Distortion of Pseudo Random Data at 5 Mb/s.

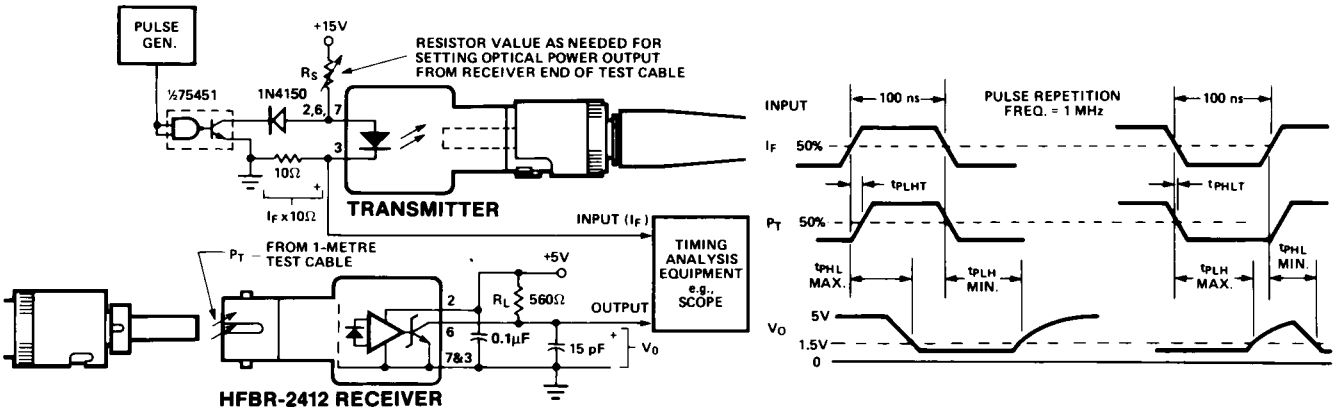


Figure 8. System Propagation Delay Test Circuit and Waveform Timing Definitions.

Ethernet 20 MBd Link (HFBR-14X4/24X6)

(refer to Application Note 1038 for details)

Typical Link Performance

Parameter	Symbol	Typ.[1,2]	Units	Conditions
Receiver Sensitivity		-34.4	dBm average	20 MBd D2D2 Hexadecimal Data 2 km 62.5/125 µm fiber
Link Jitter		7.56	ns pk-pk	ECL Out Receiver
		7.03	ns pk-pk	TTL Out Receiver
Transmitter Jitter		0.763	ns pk-pk	20 MBd D2D2 Hexadecimal Data
Optical Power	P_T	-15.2	dBm average	20 MBd D2D2 Hexadecimal Data Peak $I_{F,ON}$ = 60 mA
LED rise time	t_r	1.30	ns	1 MHz Square Wave Input
LED fall time	t_f	3.08	ns	
Mean difference	$\|t_r - t_f\|$	1.77	ns	
Bit Error Rate	BER	10^{-10}		
Output Eye Opening		36.7	ns	At AUI Receiver Output
Data Format 50% Duty Factor		20	MBd	

Notes:
1. Typical data at T_A = 25°C, V_{CC} = 5.0 V dc.
2. Typical performance of circuits shown in Figure 1 and Figure 3 of AN-1038 (see applications support section).

Token Ring 32 MBd Link (HFBR-14X4/24X6)

(refer to Application Note 1065 for details)

Typical Link Performance

Parameter	Symbol	Typ.[1,2]	Units	Conditions
Receiver Sensitivity		-34.1	dBm average	32 MBd D2D2 Hexadecimal Data 2 km 62.5/125 µm fiber
Link Jitter		6.91	ns pk-pk	ECL Out Receiver
		5.52	ns pk-pk	TTL Out Receiver
Transmitter Jitter		0.823	ns pk-pk	32 MBd D2D2 Hexadecimal Data
Optical Power Logic Level “0”	$P_{T\,ON}$	-12.2	dBm peak	Transmitter TTL in $I_{F\,ON}$ = 60 mA, $I_{F\,OFF}$ = 1 mA
Optical Power Logic Level “1”	$P_{T\,OFF}$	-82.2		
LED Rise Time	t_r	1.3	nsec	1 MHz Square Wave Input
LED Fall Time	t_f	3.08	nsec	
Mean Difference	$\|t_r - t_f\|$	1.77	nsec	
Bit Error Rate	BER	10^{-10}		
Data Format 50% Duty Factor		32	MBd	

Notes:
1. Typical data at T_A = 25°C, V_{CC} = 5.0 V dc.
2. Typical performance of circuits shown in Figure 1 and Figure 3 of AN-1065 (see applications support section)

155 MBd Link (HFBR-14X4/24X6)

(refer to Application Bulletin 78 for details)

Typical Link Performance

Parameter	Symbol	Typ.[1,2]	Units	Max.	Units	Conditions	Ref.
Optical Power Budget with 50/125 µm fiber	OPB_{50}	7.9	13.9		dB	NA = 0.2	Note 2
Optical Power Budget with 62.5/125 µm fiber	OPB_{62}	11.7	17.7		dB	NA = 0.27	
Optical Power Budget with 100/140 µm fiber	OPB_{100}	11.7	17.7		dB	NA = 0.30	
Optical Power Budget with 200 µm HCSfFiber	OPB_{200}	16.0	22.0		dB	NA = 0.35	
Data Format 20% to 80% Duty Factor		1		175	MBd		
System Pulse Width Distortion	$\lvert t_{PLH} - t_{PHL} \rvert$		1		ns	PR = -7 dBm Peak 1 meter 62.5/125 µm fiber	
Bit Error Rate	BER		10^{-9}			Data Rate < 100 MBaud PR >-31 dBm Peak	Note 2

Notes:

1. Typical data at T_A = 25°C, V_{CC} = 5.0 V dc, PECL serial interface.
2. Typical OPB was determined at a probability of error (BER) of 10^{-9}. Lower probabilities of error can be achieved with short fibers that have less optical loss.

HFBR-14X2/14X4 Low-Cost High-Speed Transmitters

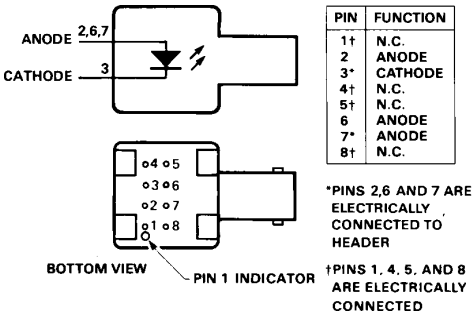
Description

The HFBR-14XX fiber optic transmitter contains an 820 nm AlGaAs emitter capable of efficiently launching optical power into four different optical fiber sizes: 50/125 µm, 62.5/125 µm, 100/140 µm, and 200 µm HCS®. This allows the designer flexibility in choosing the fiber size. The HFBR-14XX is designed to operate with the Hewlett-Packard HFBR-24XX fiber optic receivers.

The HFBR-14XX transmitter's high coupling efficiency allows the emitter to be driven at low current levels resulting in low power consumption and increased reliability of the transmitter. The HFBR-14X4 high power transmitter is optimized for small size fiber and typically can launch -15.8 dBm optical power at 60 mA into 50/125 µm fiber and -12 dBm into 62.5/125 µm fiber. The HFBR-14X2 standard transmitter typically can launch -12 dBm of optical power at 60 mA into 100/140 µm fiber cable. It is ideal for large size fiber such as 100/140 µm. The high launched optical power level is useful for systems where star couplers, taps, or inline connectors create large fixed losses.

Consistent coupling efficiency is assured by the double-lens optical system (Figure 1). Power coupled into any of the three fiber types varies less than 5 dB from part to part at a given drive current and temperature. Consistent coupling efficiency reduces receiver dynamic range requirements which allows for longer link lengths.

Housed Product

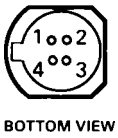


PIN	FUNCTION
1†	N.C.
2	ANODE
3*	CATHODE
4†	N.C.
5†	N.C.
6	ANODE
7*	ANODE
8†	N.C.

*PINS 2,6 AND 7 ARE ELECTRICALLY CONNECTED TO HEADER

†PINS 1, 4, 5, AND 8 ARE ELECTRICALLY CONNECTED

Unhoused Product



PIN	FUNCTION
1	ANODE
2	CATHODE
3	ANODE
4	ANODE

Absolute Maximum Ratings

Parameter		Symbol	Min.	Max.	Units	Reference
Storage Temperature		T_S	-55	+85	°C	
Operating Temperature		T_A	-40	+85	°C	
Lead Soldering Cycle	Temp.			+260	°C	
	Time			10	sec	
Forward Input Current	Peak	I_{FPK}		200	mA	Note 1
	dc	I_{Fdc}		100	mA	
Reverse Input Voltage		V_{BR}		1.8	V	

Electrical/Optical Specifications -40°C to +85°C unless otherwise specified.

Parameter	Symbol	Min.	Typ.[2]	Max.	Units	Conditions	Reference
Forward Voltage	V_F	1.48	1.70	2.09	V	I_F = 60 mA dc	Figure 9
			1.84			I_F = 100 mA dc	
Forward Voltage Temperature Coefficient	$\Delta V_F/\Delta T$		-0.22		mV/°C	I_F = 60 mA dc	Figure 9
			-0.18			I_F = 100 mA dc	
Reverse Input Voltage	V_{BR}	1.8	3.8		V	I_F = 100 µA dc	
Peak Emission Wavelength	λ_P	792	820	865	nm		
Diode Capacitance	C_T		55		pF	V = 0, f = 1 MHz	
Optical Power Temperature Coefficient	$\Delta P_T/\Delta T$		-0.006		dB/°C	I = 60 mA dc	
			-0.010			I = 100 mA dc	
Thermal Resistance	θ_{JA}		260		°C/W		Notes 3, 8
14X2 Numerical Aperture	NA		0.49				
14X4 Numerical Aperture	NA		0.31				
14X2 Optical Port Diameter	D		290		µm		Note 4
14X4 Optical Port Diameter	D		150		µm		Note 4

HFBR-14X2 Output Power Measured Out of 1 Meter of Cable

Parameter	Symbol	Min.	Typ.[2]	Max.	Unit	Conditions		Reference
50/125 µm Fiber Cable NA = 0.2	P_{T50}	-21.8	-18.8	-16.8	dBm peak	T_A = 25°C	I_F = 60 mA dc	Notes 5, 6, 9
		-22.8		-15.8				
		-20.3	-16.8	-14.4		T_A = 25°C	I_F = 100 mA dc	
		-21.9		-13.8				
62.5/125 µm Fiber Cable NA = 0.275	P_{T62}	-19.0	-16.0	-14.0	dBm peak	T_A = 25°C	I_F = 60 mA dc	
		-20.0		-13.0				
		-17.5	-14.0	-11.6		T_A = 25°C	I_F = 100 mA dc	
		-19.1		-11.0				
100/140 µm Fiber Cable NA = 0.3	P_{T100}	-15.0	-12.0	-10.0	dBm peak	T_A = 25°C	I_F = 60 mA dc	
		16.0		-9.0				
		-13.5	-10.0	-7.6		T_A = 25°C	I_F = 100 mA dc	
		-15.1		-7.0				
200 µm HCS Fiber Cable NA = 0.37	P_{T200}	-10.7	-7.1	-4.7	dBm peak	T_A = 25°C	I_F = 60 mA dc	
		-11.7		-3.7				
		-9.2	-5.2	-2.3		T_A = 25°C	I_F = 100 mA dc	
		-10.8		-1.7				

CAUTION: The small junction sizes inherent to the design of these components increase the components' susceptibility to damage from electrostatic discharge (ESD). It is advised that normal static precautions be taken in handling and assembly of these components to prevent damage and/or degradation which may be induced by ESD.

HFBR-14X4 Output Power Measured Out of 1 Meter of Cable

Parameter	Symbol	Min.	Typ.[2]	Max.	Unit	Conditions		Reference
50/125 µm Fiber Cable NA = 0.2	PT50	-18.8	-15.8	-13.8	dBm peak	T_A = 25°C	I_F = 60 mA dc	Notes 5, 6, 9
		-19.8		-12.8				
		-17.3	-13.8	-11.4		T_A = 25°C	I_F = 100 mA dc	
		-18.9		-10.8				
62.5/125 µm Fiber Cable NA = 0.275	PT62	-15.0	-12.0	-10.0	dBm peak	T_A = 25°C	I_F = 60 mA dc	
		-16.0		-9.0				
		-13.5	-10.0	-7.6		T_A = 25°C	I_F = 100 mA dc	
		-15.1		-7.0				
100/140 µm Fiber Cable NA = 0.3	PT100	-9.5	-6.5	-4.5	dBm peak	T_A = 25°C	I_F = 60 mA dc	
		-10.5		-3.5				
		-8.0	-4.5	-2.1		T_A = 25°C	I_F = 100 mA dc	
		-9.6		-1.5				
200 µm HCS Fiber Cable NA = 0.37	PT200	-5.2	-3.7	+0.8	dBm peak	T_A = 25°C	I_F = 60 mA dc	
		-6.2		+1.8				
		-3.7	-1.7	+3.2		T_A = 25°C	I_F = 100 mA dc	
		-5.3		+3.8				

14X2/14X4 Dynamic Characteristics

Parameter	Symbol	Min.	Typ.[2]	Max.	Units	Conditions	Reference
Rise Time, Fall Time (10% to 90%)	t_r, t_f		4.0	6.5	nsec No Pre-bias	I_F = 60 mA Figure 12	Note 7,
Rise Time, Fall Time (10% to 90%)	t_r, t_f		3.0		nsec	I_F = 10 to 100 mA	Note 7, Figure 11
Pulse Width Distortion	PWD		0.5		nsec		Figure 11

Notes:
1. For I_{FPK} > 100 mA, the time duration should not exceed 2 ns.
2. Typical data at T_A = 25°C.
3. Thermal resistance is measured with the transmitter coupled to a connector assembly and mounted on a printed circuit board.
4. D is measured at the plane of the fiber face and defines a diameter where the optical power density is within 10 dB of the maximum.
5. P_T is measured with a large area detector at the end of 1 meter of mode stripped cable, with an ST® precision ceramic ferrule (MIL-STD-83522/13) for HFBR-1412/1414, and with an SMA 905 precision ceramic ferrule for HFBR-1402/1404.
6. When changing µW to dBm, the optical power is referenced to 1 mW (1000 µW). Optical Power P (dBm) = 10 log P (µW)/1000 µW.
7. Pre-bias is recommended if signal rate >10 MBd, see recommended drive circuit in Figure 11.
8. Pins 2, 6 and 7 are welded to the anode header connection to minimize the thermal resistance from junction to ambient. To further reduce the thermal resistance, the anode trace should be made as large as is consistent with good RF circuit design.
9. Fiber NA is measured at the end of 2 meters of mode stripped fiber, using the far-field pattern. NA is defined as the sine of the half angle,determined at 5% of the peak intensity point. When using other manufacturer's fiber cable, results will vary due to differing NA values and specification methods.

All HFBR-14XX LED transmitters are classified as IEC 825-1 Accessible Emission Limit (AEL) Class 1 based upon the current proposed draft scheduled to go in to effect on January 1, 1997. AEL Class 1 LED devices are considered eye safe. See Hewlett-Packard Application Note XXXXX for more information.

CAUTION: The small junction sizes inherent to the design of these components increase the components' susceptibility to damage from electrostatic discharge (ESD). It is advised that normal static precautions be taken in handling and assembly of these components to prevent damage and/or degradation which may be induced by ESD.

Recommended Drive Circuits

The circuit used to supply current to the LED transmitter can significantly influence the optical switching characteristics of the LED. The optical rise/fall times and propagation delays can be improved by using the appropriate circuit techniques. The LED drive circuit shown in Figure 11 uses frequency compensation to reduce the typical rise/fall times of the LED and a small pre-bias voltage to minimize propagation delay differences that cause pulse-width distortion. The circuit will typically produce rise/fall times of 3 ns, and a total jitter including pulse-width distortion of less than 1 ns. This circuit is recommended for applications requiring low edge jitter or high-speed data transmission at signal rates of up to 155 MBd. Component values for this circuit can be calculated for different LED drive currents using the equations shown below. For additional details about LED drive circuits, the reader is encouraged to read Hewlett-Packard Application Bulletin 78 and Application Note 1038.

$$R_y = \frac{(V_{CC} - V_F) + 3.97\ (V_{CC} - V_F - 1.6\ V)}{I_{F\,ON}\,(A)}$$

$$R_{X1} = \frac{1}{2}\left(\frac{R_y}{3.97}\right)$$

$$R_{EQ2}(\Omega) = R_{X1} - 1$$

$$R_{X2} = R_{X3} = R_{X4} = 3(R_{EQ2})$$

$$C(pF) = \frac{2000(ps)}{R_{X1}(\Omega)}$$

Example for $I_{F\,ON}$ = 100 mA: V_F can be obtained from Figure 9 (= 1.84 *V*).

$$R_y = \frac{(5 - 1.84) + 3.97\ (5 - 1.84 - 1.6)}{0.100}$$

$$R_y = \frac{3.16 + 6.19}{0.100} = 93.5\ \Omega$$

$$R_{X1} = \frac{1}{2}\left(\frac{93.5}{3.97}\right) = 11.8\ \Omega$$

$$R_{EQ2} = 11.8 - 1 = 10.8\ \Omega$$

$$R_{X2} = R_{X3} = R_{X4} = 3(10.8) = 32.4\ \Omega$$

$$C = \frac{2000\ ps}{11.8\ \Omega} = 169\ pF$$

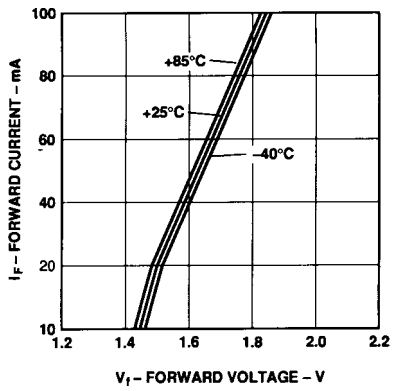


Figure 9. Forward Voltage and Current Characteristics.

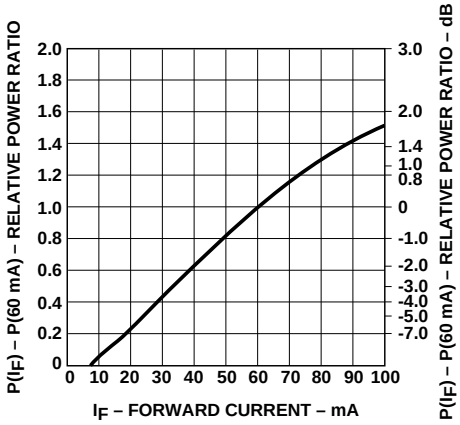


Figure 10. Normalized Transmitter Output vs. Forward Current.

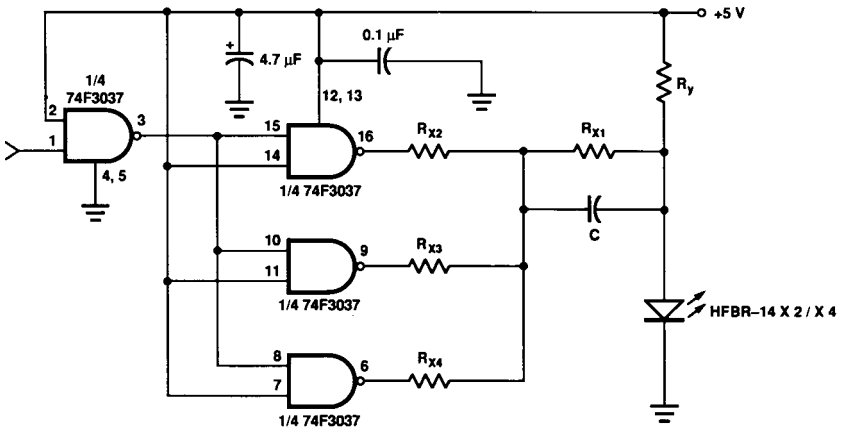


Figure 11. Recommended Drive Circuit.

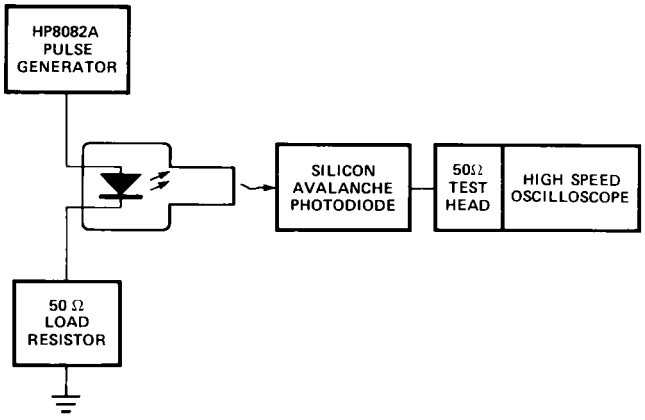


Figure 12. Test Circuit for Measuring t_r, t_f.

HFBR-24X2 Low-Cost 5MBd Receiver

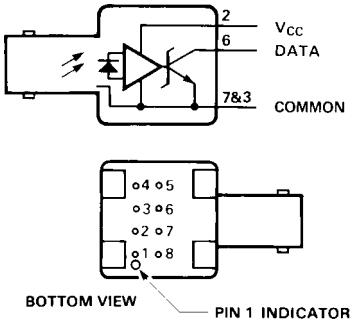
Description

The HFBR-24X2 fiber optic receiver is designed to operate with the Hewlett-Packard HFBR-14XX fiber optic transmitter and 50/125 µm, 62.5/125 µm, 100/140 µm, and 200 µm HCS® fiber optic cable. Consistent coupling into the receiver is assured by the lensed optical system (Figure 1). Response does not vary with fiber size ≤0.100 µm.

The HFBR-24X2 receiver incorporates an integrated photo IC containing a photodetector and dc amplifier driving an open-collector Schottky output transistor. The HFBR-24X2 is designed for direct interfacing to popular logic families. The absence of an internal pull-up resistor allows the open-collector output to be used with logic families such as CMOS requiring voltage excursions much higher than V_{CC}.

Both the open-collector "Data" output Pin 6 and V_{CC} Pin 2 are referenced to "Com" Pin 3, 7. The "Data" output allows busing, strobing and wired "OR" circuit configurations. The transmitter is designed to operate from a single +5 V supply. It is essential that a bypass capacitor (0.1 µF ceramic) be connected from Pin 2 (V_{CC}) to Pin 3 (circuit common) of the receiver.

Housed Product

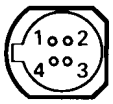


PIN	FUNCTION
1†	N.C.
2	V_{CC} (5 V)
3*	COMMON
4†	N.C.
5†	N.C.
6	DATA
7*	COMMON
8†	N.C.

*PINS 3 AND 7 ARE ELECTRICALLY CONNECTED TO HEADER

†PINS 1, 4, 5, AND 8 ARE ELECTRICALLY CONNECTED

Unhoused Product



PIN	FUNCTION
1	V_{CC} (5 V)
2	COMMON
3	DATA
4	COMMON

Absolute Maximum Ratings

Parameter		Symbol	Min.	Max.	Units	Reference
Storage Temperature		T_S	-55	+85	°C	
Operating Temperature		T_A	-40	+85	°C	
Lead Soldering Cycle	Temp.			+260	°C	Note 1
	Time			10	sec	
Supply Voltage		V_{CC}	-0.5	7.0	V	
Output Current		I_O		25	mA	
Output Voltage		V_O	-0.5	18.0	V	
Output Collector Power Dissipation		$P_{O\,AV}$		40	mW	
Fan Out (TTL)		N		5		Note 2

Electrical/Optical Characteristics -40°C to + 85°C unless otherwise specified

Fiber sizes with core diameter ≤100 µm and NA ≤0.35, 4.75 V ≤V_{CC} ≤5.25 V

Parameter	Symbol	Min.	Typ.[3]	Max.	Units	Conditions	Reference
High Level Output Current	I_{OH}		5	250	µA	V_O = 18 P_R < -40 dBm	
Low Level Output Voltage	V_{OL}		0.4	0.5	V	I_O = 8 mA P_R > -24 dBm	
High Level Supply Current	I_{CCH}		3.5	6.3	mA	V_{CC} = 5.25 V P_R < -40 dBm	
Low Level Supply Current	I_{CCL}		6.2	10	mA	V_{CC} = 5.25 V P_R > -24 dBm	
Equivalent N.A.	NA		0.50				
Optical Port Diameter	D		400		µm		Note 4

Dynamic Characteristics

-40°C to +85°C unless otherwise specified; 4.75 V ≤V_{CC} ≤5.25 V; BER ≤10^{-9}

Parameter	Symbol	Min.	Typ.[3]	Max.	Units	Conditions	Reference
Peak Optical Input Power Logic Level HIGH	P_{RH}			-40	dBm pk	λ_P = 820 nm	Note 5
				0.1	µW pk		
Peak Optical Input Power Logic Level LOW	P_{RL}	-25.4		-9.2	dBm pk	T_A = +25°C, I_{OL} = 8 mA	Note 5
		2.9		120	µW pk		
		-24.0		-10.0	dBm pk	I_{OL} = 8 mA	
		4.0		100	µW pk		
Propagation Delay LOW to HIGH	t_{PLHR}		65		ns	T_A = 25°C, P_R = -21 dBm, Data Rate = 5 MBd	Note 6
Propagation Delay HIGH to LOW	t_{PHLR}		49		ns		

Notes:

1. 2.0 mm from where leads enter case.
2. 8 mA load (5 x 1.6 mA), R_L = 560 Ω.
3. Typical data at T_A = 25°C, V_{CC} = 5.0 Vdc.
4. D is the effective diameter of the detector image on the plane of the fiber face. The numerical value is the product of the actual detector diameter and the lens magnification.
5. Measured at the end of 100/140 µm fiber optic cable with large area detector.
6. Propagation delay through the system is the result of several sequentially-occurring phenomena. Consequently it is a combination of data-rate-limiting effects and of transmission-time effects. Because of this, the data-rate limit of the system must be described in terms of time differentials between delays imposed on falling and rising edges.
7. As the cable length is increased, the propagation delays increase at 5 ns per meter of length. Data rate, as limited by pulse width distortion, is not affected by increasing cable length if the optical power level at the receiver is maintained.

CAUTION: The small junction sizes inherent to the design of these components increase the components' susceptibility to damage from electrostatic discharge (ESD). It is advised that normal static precautions be taken in handling and assembly of these components to prevent damage and/or degradation which may be induced by ESD.

HFBR-24X6 Low-Cost 125 MHz Receiver

Description

The HFBR-24X6 fiber optic receiver is designed to operate with the Hewlett-Packard HFBR-14XX fiber optic transmitters and 50/125 µm, 62.5/125 µm, 100/140 µm and 200 µm HCS® fiber optic cable. Consistent coupling into the receiver is assured by the lensed optical system (Figure 1). Response does not vary with fiber size for core diameters of 100 µm or less.

The receiver output is an analog signal which allows follow-on circuitry to be optimized for a variety of distance/data rate requirements. Low-cost external components can be used to convert the analog output to logic compatible signal levels for various data formats and data rates up to 175 MBd. This distance/data rate tradeoff results in increased optical power budget at lower data rates which can be used for additional distance or splices.

The HFBR-24X6 receiver contains a PIN photodiode and low noise transimpedance pre-amplifier integrated circuit. The HFBR-24X6 receives an optical signal and converts it to an analog voltage. The output is a buffered emitter-follower. Because the signal amplitude from the HFBR-24X6 receiver is much larger than from a simple PIN photodiode, it is less susceptible to EMI, especially at high signaling rates. For very noisy environments, the conductive or metal port option is recommended. A receiver dynamic range of 23 dB over temperature is achievable (assuming 10^{-9} BER).

The frequency response is typically dc to 125 MHz. Although the HFBR-24X6 is an analog receiver, it is compatible with digital systems. Please refer to Application Bulletin 78 for simple and inexpensive circuits that operate at 155 MBd or higher.

The recommended ac coupled receiver circuit is shown in Figure 12. It is essential that a 10 ohm resistor be connected between pin 6 and the power supply, and a 0.1 µF ceramic bypass capacitor be connected between the power supply and ground. In addition, pin 6 should be filtered to protect the receiver from noisy host systems. Refer to AN 1038, 1065, or AB 78 for details.

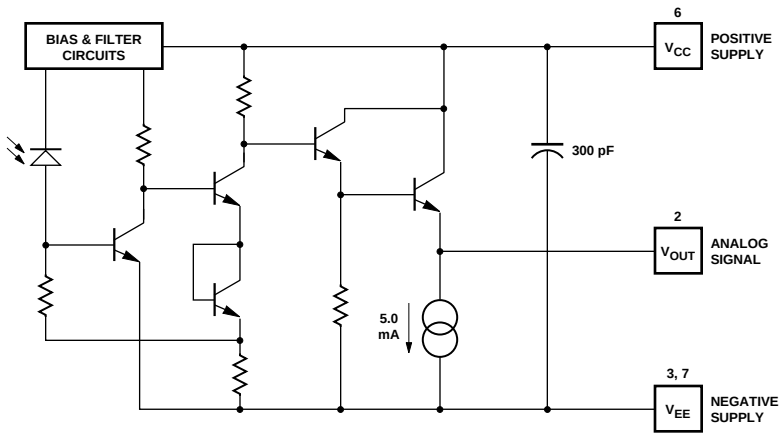
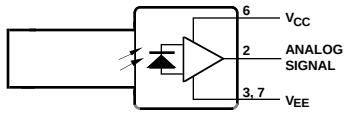
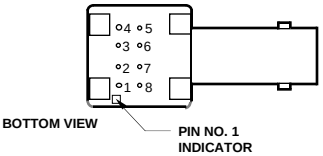


Figure 11. Simplified Schematic Diagram.

Housed Product





PIN	FUNCTION
1†	N.C.
2	SIGNAL
3*	V_{EE}
4†	N.C.
5†	N.C.
6	V_{CC}
7*	V_{EE}
8†	N.C.

*** PINS 3 AND 7 ARE ELECTRICALLY CONNECTED TO THE HEADER.**

† PINS 1, 4, 5, AND 8 ARE ISOLATED FROM THE INTERNAL CIRCUITRY, BUT ARE ELECTRICALLY CONNECTED TO EACH OTHER.

Unhoused Product

PIN	FUNCTION
1	SIGNAL
2*	V_{EE}
3	V_{CC}
4*	V_{EE}

CAUTION: The small junction sizes inherent to the design of these components increase the components' susceptibility to damage from electrostatic discharge (ESD). It is advised that normal static precautions be taken in handling and assembly of these components to prevent damage and/or degradation which may be induced by ESD.

Absolute Maximum Ratings

Parameter		Symbol	Min.	Max.	Units	Reference
Storage Temperature		T_S	-55	+85	°C	
Operating Temperature		T_A	-40	+85	°C	
Lead Soldering Cycle	Temp.			+260	°C	Note 1
	Time			10	s	
Supply Voltage		V_{CC}	-0.5	6.0	V	
Output Current		I_O		25	mA	
Signal Pin Voltage		V_{SIG}	-0.5	V_{CC}	V	

Electrical/Optical Characteristics

-40°C to +85°C; 4.75 V ≤Supply Voltage ≤5.25 V, R_{LOAD} = 511 Ω, Fiber sizes with core diameter ≤100 µm, and N.A. ≤-0.35 unless otherwise specified

Parameter	Symbol	Min.	Typ.[2]	Max.	Units	Conditions	Reference
Responsivity	R_P	5.3	7	9.6	mV/µW	T_A= 25°C @ 820 nm, 50 MHz	Note 3, 4 Figure 16
		4.5		11.5	mV/µW	@ 820 nm, 50 MHz	
RMS Output Noise Voltage	V_{NO}		0.40	0.59	mV	Bandwidth Filtered @ 75 MHz P_R = 0 µW	Note 5
				0.70	mV	Unfiltered Bandwidth P_R = 0 µW	Figure 13
Equivalent Input Optical Noise Power (RMS)	P_N		-43.0	-41.4	dBm	Bandwidth Filtered @ 75 MHz	
			0.050	0.065	µW		
Optical Input Power (Overdrive)	P_R			-7.6	dBm pk	T_A = 25°C	Figure 14 Note 6
				175	µW pk		
				-8.2	dBm pk		
				150	µW pk		
Output Impedance	Z_o		30		Ω	Test Frequency = 50 MHz	
dc Output Voltage	$V_{o\ dc}$	-4.2	-3.1	-2.4	V	P_R = 0 µW	
Power Supply Current	I_{EE}		9	15	mA	R_{LOAD} = 510 Ω	
Equivalent N.A.	NA		0.35				
Equivalent Diameter	D		324		µm		Note 7

CAUTION: The small junction sizes inherent to the design of these components increase the components' susceptibility to damage from electrostatic discharge (ESD). It is advised that normal static precautions be taken in handling and assembly of these components to prevent damage and/or degradation which may be induced by ESD.

Dynamic Characteristics -40°C to +85°C; 4.75 V ≤Supply Voltage ≤5.25 V; R_{LOAD} = 511 Ω, C_{LOAD} = 5 pF unless otherwise specified

Parameter	Symbol	Min.	Typ.[2]	Max.	Units	Conditions	Reference
Rise/Fall Time 10% to 90%	t_r, t_f		3.3	6.3	ns	P_R = 100 µW peak	Figure 15
Pulse Width Distortion	PWD		0.4	2.5	ns	P_R = 150 µW peak	Note 8, Figure 14
Overshoot			2		%	P_R = 5 µW peak, t_r = 1.5 ns	Note 9
Bandwidth (Electrical)	BW		125		MHz	-3 dB Electrical	
Bandwidth - Rise Time Product			0.41		Hz • s		Note 10

Notes:

1. 2.0 mm from where leads enter case.
2. Typical specifications are for operation at T_A = 25°C and V_{CC} = +5 V dc.
3. For 200 µm HCS fibers, typical responsivity will be 6 mV/µW. Other parameters will change as well.
4. Pin #2 should be ac coupled to a load ≥510 ohm. Load capacitance must be less than 5 pF.
5. Measured with a 3 pole Bessel filter with a 75 MHz, -3 dB bandwidth. Recommended receiver filters for various bandwidths are provided in Application Bulletin 78.
6. Overdrive is defined at PWD = 2.5 ns.
7. D is the effective diameter of the detector image on the plane of the fiber face. The numerical value is the product of the actual detector diameter and the lens magnification.
8. Measured with a 10 ns pulse width, 50% duty cycle, at the 50% amplitude point of the waveform.
9. Percent overshoot is defined as:

$$\left(\frac{V_{PK} - V_{100\%}}{V_{100\%}}\right) \times 100\%$$

10. The conversion factor for the rise time to bandwidth is 0.41 since the HFBR-24X6 has a second order bandwidth limiting characteristic.

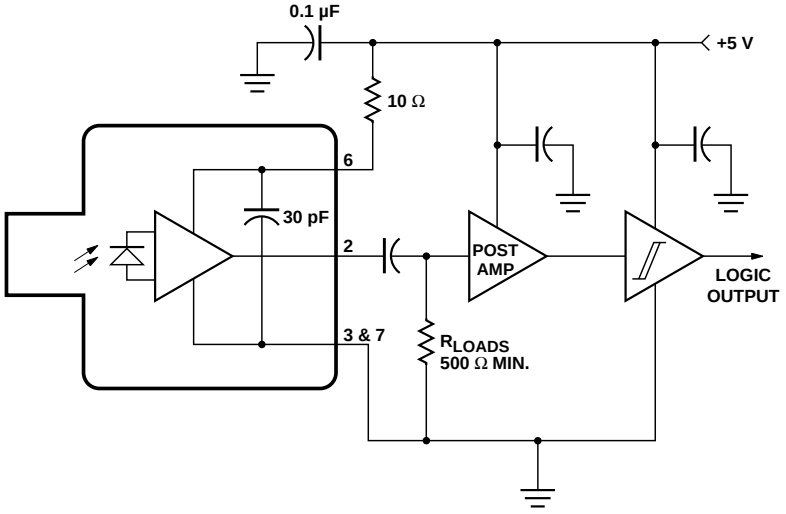


Figure 12. Recommended ac Coupled Receiver Circuit. (See AB 78 and AN 1038 for more information.)

CAUTION: The small junction sizes inherent to the design of these components increase the components' susceptibility to damage from electrostatic discharge (ESD). It is advised that normal static precautions be taken in handling and assembly of these components to prevent damage and/or degradation which may be induced by ESD.

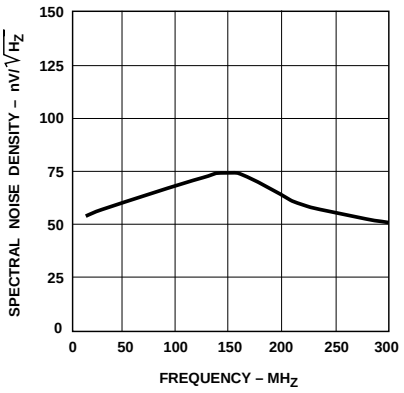


Figure 13. Typical Spectral Noise Distortion vs. Peak Input Power.

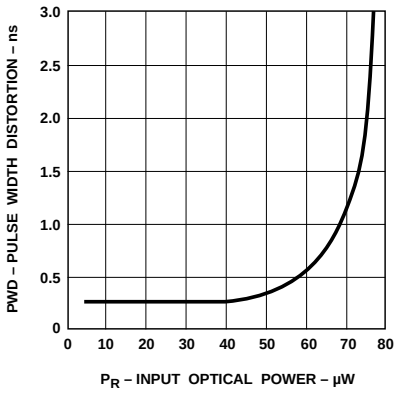


Figure 14. Typical Pulse Width Density vs. Frequency.

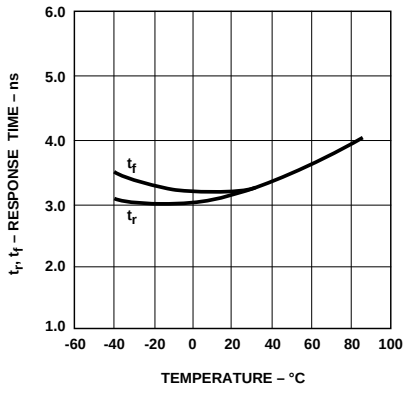


Figure 15. Typical Rise and Fall Times vs. Temperature.

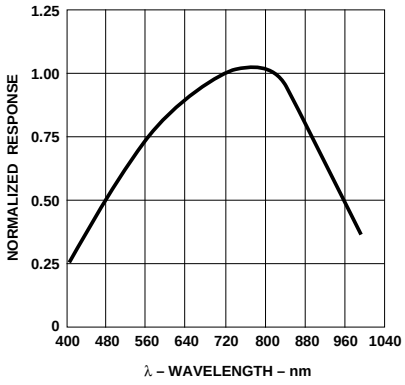


Figure 16. Receiver Spectral Response Normalized to 820 nm.

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Data subject to change.
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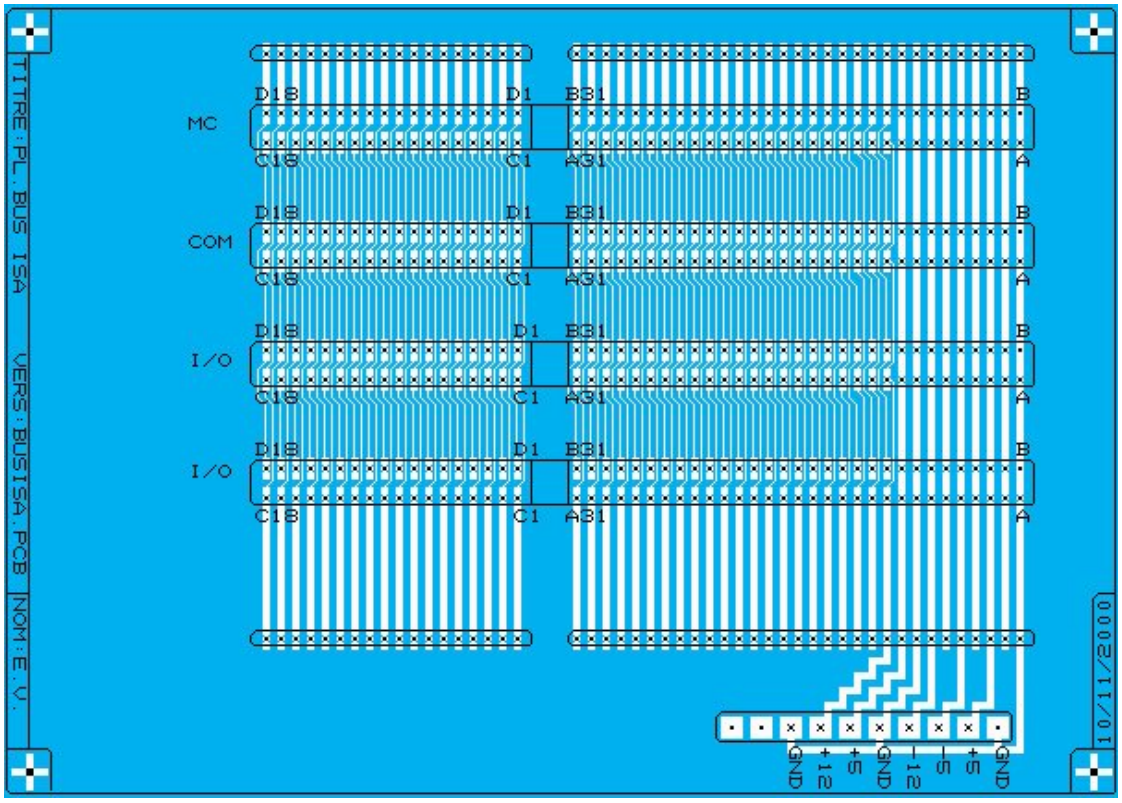
Obsoletes 5962-6181E, 5962-6111E, 5962-8095E, 5091-9103E

Printed in U.S.A. 5965-1655E (9/96)

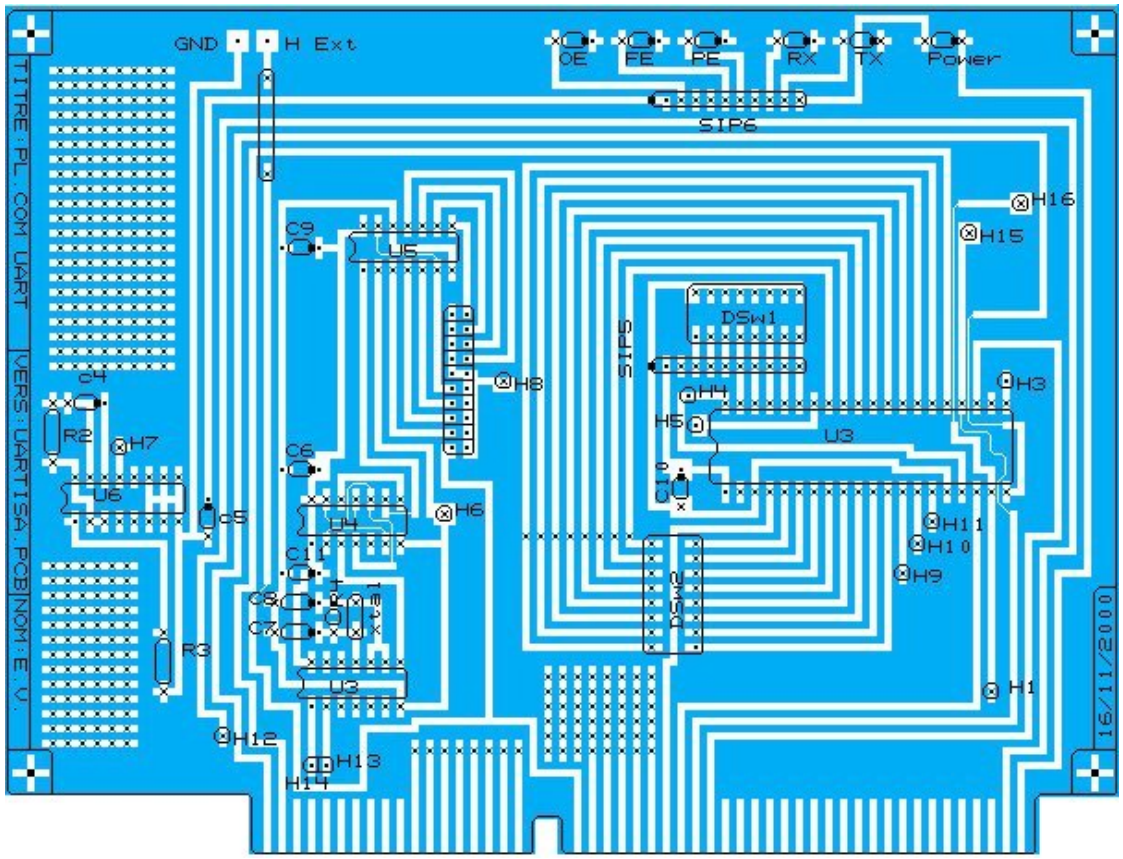
DISPOSITION DE LA PLAQUE BUS ISA



LISTE DES PIÈCES

Item	Nb	Valeur	Attribue	ID
1	4	CONN ISA	72 pins	CON1, CON2, CON3, CON4
2	1	BORNIER 10	-	CON5

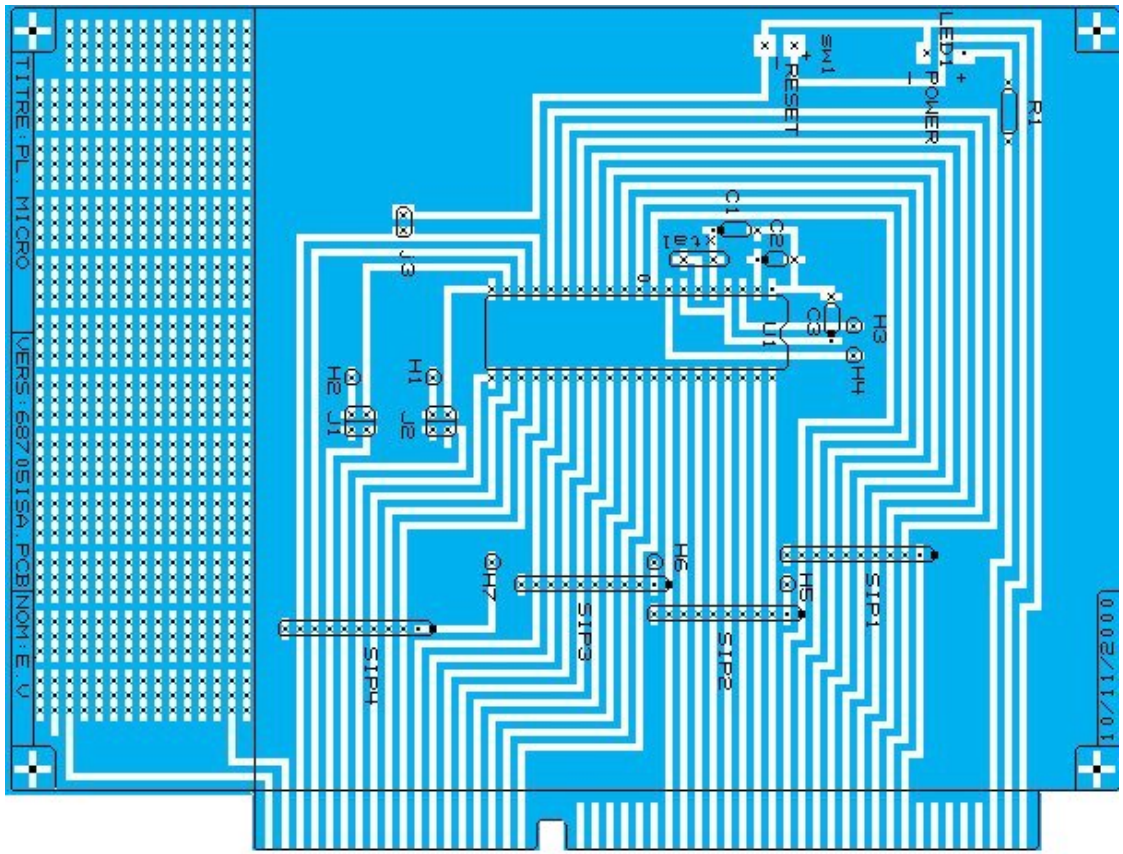
Disposition de la plaque de communication UART



Liste des pièces

Item	Nb	Valeur	Attribue	ID
1	1	15nF	POLAR0.6	C4
2	1	0.1uF	POLAR0.6	C5
3	3	15uF	POLAR0.6	C6,C9,C10
4	2	33pF	RAD0.2	C7,C8
5	6	LED2	Rouge	D1,D2,D3,D4,D5,D6
6	1	CONN	IDC20	J4
7	1	CONN	SIP2	J5
8	1	10k	AXIAL0.4	R2
9	1	51	AXIAL0.4	R3
10	1	10M	AXIAL0.4	R4
11	8	dipswitch	(8)	DSw1
12	8	dipswitch	(8)	DSw2
13	1	10k	SIP10	Sip5
14	1	330	SIP10	Sip6
15	1	74LS04	DIP14	U2
16	1	HD6402	(none)	U3
17	1	7474	DIP14	U4
18	1	74393	-	U5
19	1	74LS123	-	U6
20	1	4.9152MHZ	HC33/51	**XTAL2**
21	1	Socket 40	-	-
22	1	Socket 16	-	-
23	3	Socket 14	-	-

DISPOSITION DE LA PLAQUE MICROCONTRÔLEUR



LISTE DES PIÈCES

Item	Nb	Valeur	Attribue	ID
1	1	25pF	POLAR25	C1
2	2	15uF	POLAR 25 v	C2,C3
3	1	LED1	Rouge	D1
4	2	CONN	JMP4	J1,J2
5	1	CONN	JMP2	J3
6	1	330	-	R1
7	4	10k	SIP10	sip1,sip2, sip3,sip4
8	1	switch	aucun	Sw1
9	1	MC68705R3	flash	U1
10	1	Cristal 3.5795MHZ		XTAL1
11	1	Socket	40 pins	Sock1

SCHÉMA DE LA PLAQUE BUS ISA

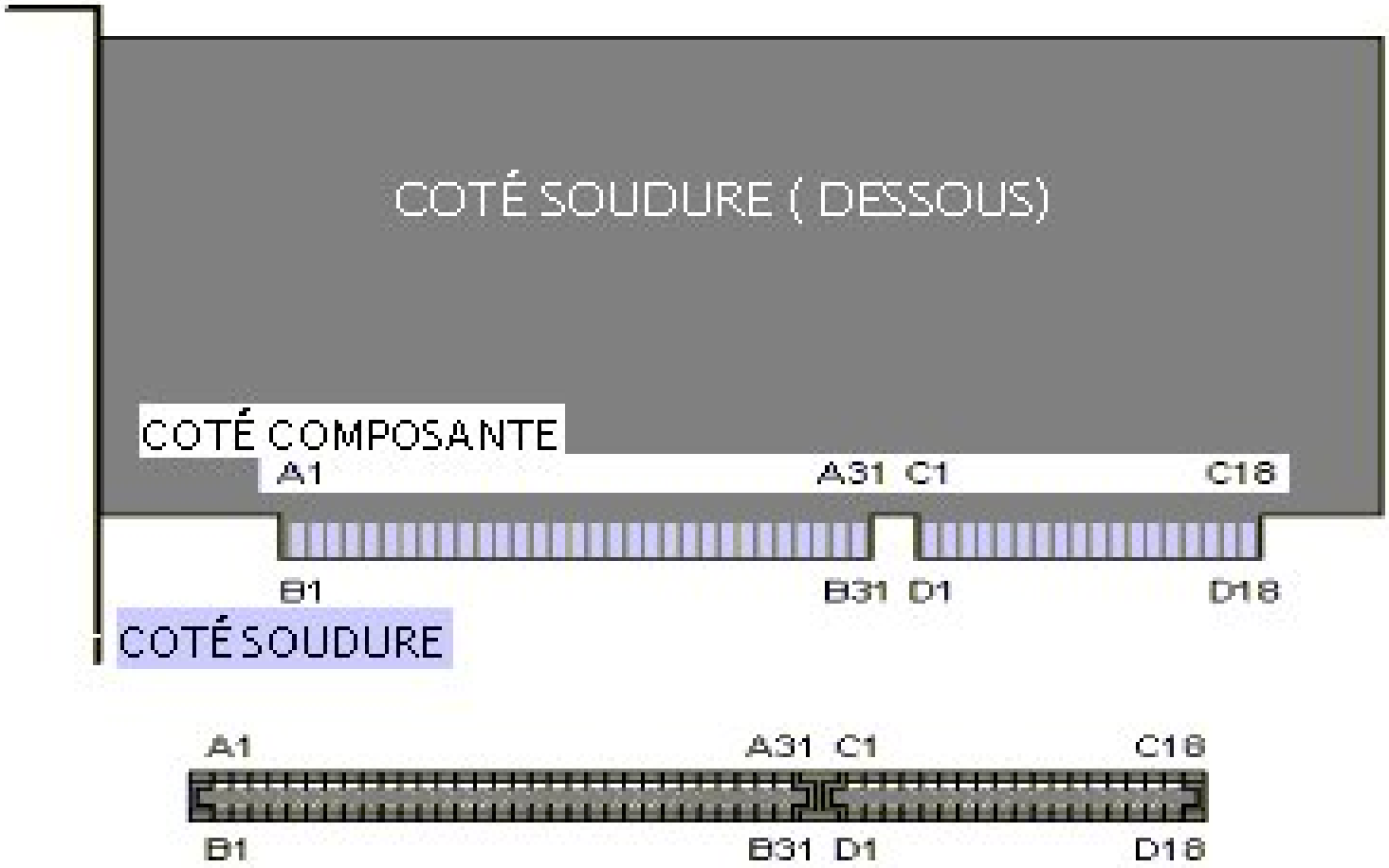
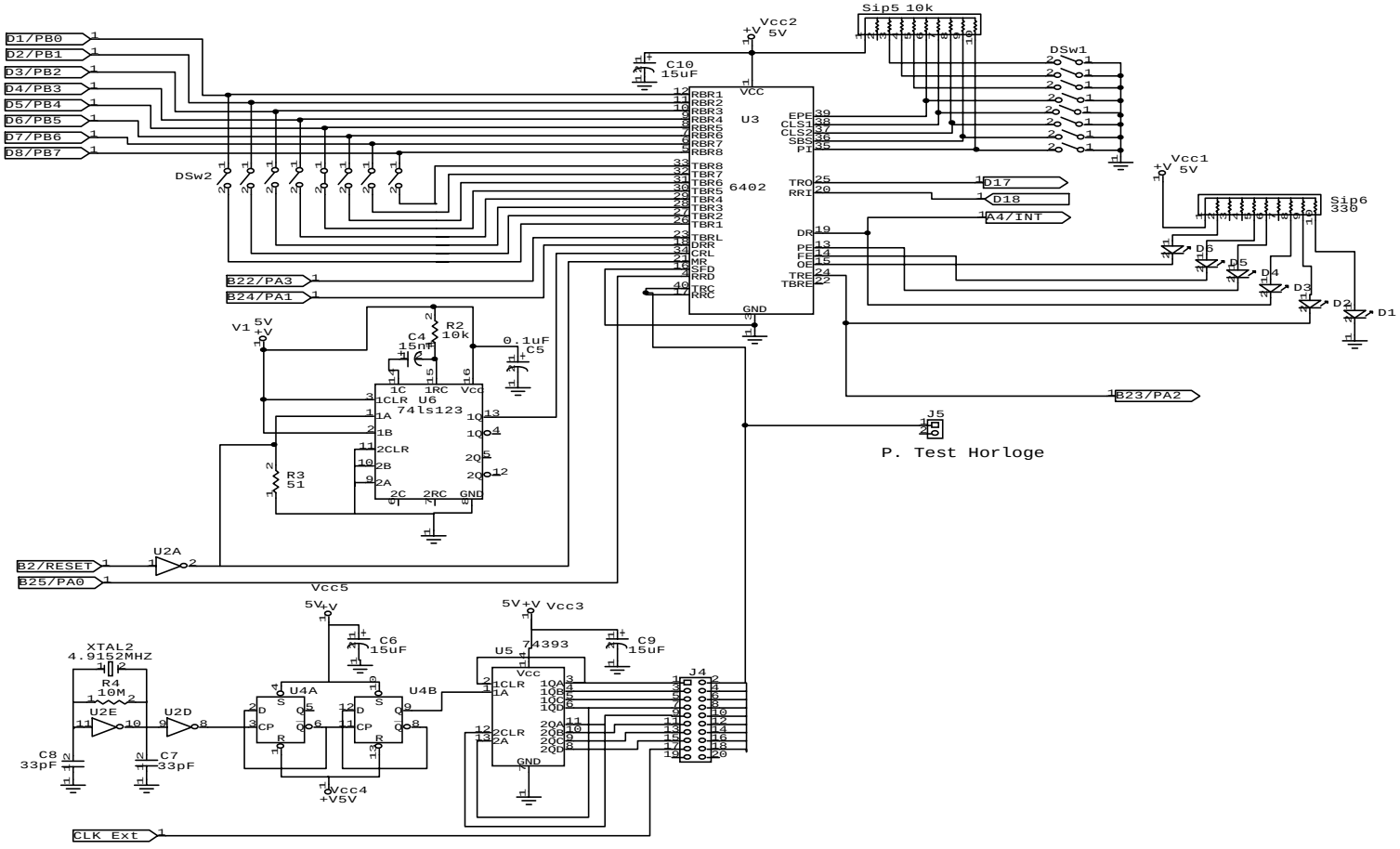


SCHÉMA DE LA PLAQUE DE COMMUNICATION UART



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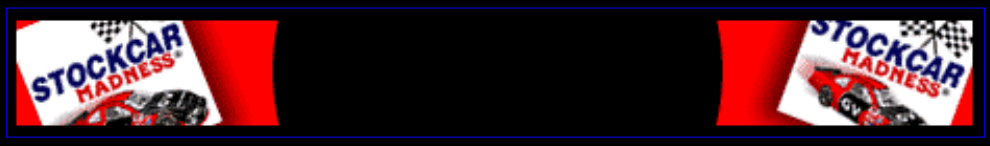

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Projet réalisé par :

Natasha Maillé
Martin Gagnon
Kevin Kennedy
Michaël Lemieux

Étudiants en Génie électrique, Option télécommunication 3e année, finissant.

But :

Rassembler et maîtriser la majorité des connaissances acquises au cours du DEC.

Développer chez l'étudiant sa capacité à travailler en équipe.

Respecter des délais déjà fixés par l'enseignant et l'étudiant.

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Réaliser un système de télécommunication complet.

Objectifs spécifiques :

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Faire de la recherche afin de trouver la documentation nécessaire à l'élaboration du projet.

Faire le montage des modules utilisés sur une plaque d'expérimentation et en étudier le fonctionnement.

Procéder à la construction de chaque module sur carte ISA.

Faire l'essai, la vérification et le dépannage de chaque modules ISA.

Développer une méthode de fonctionnement programmable sur un micro-contrôleur.

Vérifier le bon fonctionnement du programme sur assembleur.

Tester le programme final avec le système et faire du dépannage si nécessaire.

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Instauration du cahier technique sur le web.

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